Fundamentals of Environmental Pollution and Control
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Lecture No # 21
Parameters to soil for Vegetation Growth

All right when we start again, so you know here we can see you know just to observe that what we have said is that you know, that you know in two conditions that we see that you know particularly at field capacity, the soil would be perfectly friendly for vegetative growth and not necessarily certainly at soil wilting point when this is the plant would be, the plant would not find any water, any water as such to get so that you know it can generate this, its food and you know it can have a balance in its structure itself. That is called the soil wilting point, when the soil you know would that particular condition would make this plants to die, if it continues to remain in that situation for long. Particularly, the small plants die, larger plants by virtue of their entry to a lower depth of the soil they can still survive but you know you find that you know if soil wilting point particular in a drought situation, in a situation of drought you find that the soil has reached its wilting point and where wilting point means wilting point for the plants where the plants can no longer sustain, cannot no longer remain in that.

Another important when the soil is completely saturated, particularly the soil saturation is observed like this. Say if you are, if you are seeing the heavy shower I mean on the soil you will find after some time the water is beginning together on top of the soil, okay beginning together on top of the soil. So, what has happened is soil has already saturated with water only then the water has been left out, only then the water has gone out of it. So, in such situation if this is remaining continuously for quite some time in the soil itself, quite sometime in the soil itself the soil would be finally be you know would be breathless, could not find any air, could not find any air for it to sustain, for it to live. So and due to lack of air in the soil itself the soil, the plants, the plant roots they would begin to wither away begin to dry, begin to, will begin to dry down, begin to completely dry down because there would not be any air available for its respiration, for its respiration remember this. The root respiration is a very important part of the plant anyway. So, here you know this is what has to be observed about this is what has to be observed about the soil water and this is what it makes a difference. So, whatever in a particularly in an engineering decision if you are making, if you are working as an environmental specialist you should try to put the soil in the field capacity. You should try to work out see that you know the soil comes back to its say or soil is maintained at is, the soil water is maintained at field capacity.

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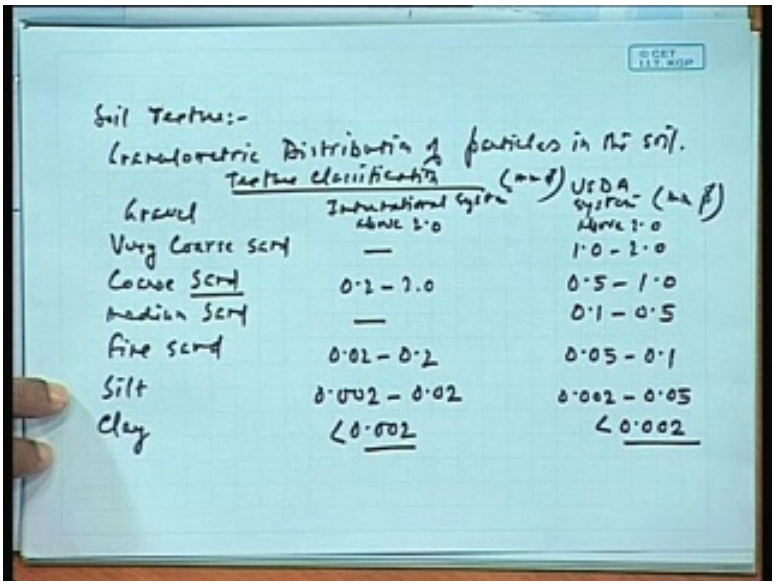

So, the soil texture, next comes is soil texture. This is the soil texture also a very important part, also a very important part of the soil not very critically important but you know on the other hand it has a great role to play. As I was discussing you yesterday as well as in the lab class and also in this, in the class, the last class that we discussed, the soil texture also has a great role to play, is nothing but soil texture is a granulometric distribution of, distribution of particles in the soil, granulometric distribution of particles in the soil. So, this is about just to say about how the soil you know the soil is distributed. So, before we go into that what are the particles or the different size of particles that we generally find out in soil. Say this is, this is what is the essentially the soil is consist of, this is gravel, gravel, very coarse, very coarse sand, coarse sand, coarse sand, medium sand, medium sand, fine sand, fine sand, silt, clay okay.

So, there are two systems actually by which you known it can be classified. This is the, this is the texture classification. So, you can see this is the classified, this is texture classification, texture classification. This is an you know is basically a British system or Internationally accepted system and another just goes as US department of agriculture system, US department of agriculture they generally explain it differently. So, both the cases it is above, if it is above it is you know in case of mm dia, mm dia, this is also mm dia above 2 mm, above 2 mm is basically gravel. So, you know above 2 mm is, above 2 mm is gravel. Gravels actually you know except for supporting the plants structure, they don't contribute much, they don't contribute much. So, this is whether I mean only purpose that it serves is mostly to provide a structure for the plant, very coarse sand, very coarse sand you know there is, if there is this distinction is not essentially available in international system. This is 1 to 1.0 to 2 is the very coarse sand whereas this coarse sand is 0.2 to 2.0, this is 0.5 to 1, this is medium sand is not existent, this is 0.1 to 0.5 right, fine sand is 0.02 to 0.2, this one is 0.05 to 0.1, silt is, silt is 0.002 to 0.02 less than, less than zero point, so is less than 0.02 less than 0.02 is clay. So, here it is also the same, only thing is 0.002 to 0.05 and this is also anything, the last one is 0.002 this is same, only you know they made a subdivision.

So, you know you can say in the international system there is nothing like coarse sand or medium sand like this it is only sand, this is only sand, they have made a, they have made a distinction as to coarse very coarse and sand, this only told as sand here. Fine sand is there is a distinction of fine sand, silt is given here 0.002 to 0.02, 0.002 to 0.02 is silt, clay is anything less than 0.002 and in both the cases this remains the same.

Now having to say this, having to say this you know there is a, there is a nomograph that is you know USDA nomograph that generally textural provides the textural classification. I'll not go into the in most of all books of, all books of, in all books of environmental engineering where the soil is dealt and in an agricultural engineering wherever it is dealt, we will find that you know this the soil nomogram, soil, this is soil nomogram is say just you know soil nomogram which is basic characteristic is this is a basically a triangle, basically a triangle just you know I'll not, this is percent clay, percent clay, percent sand and percent silt, percent silt.

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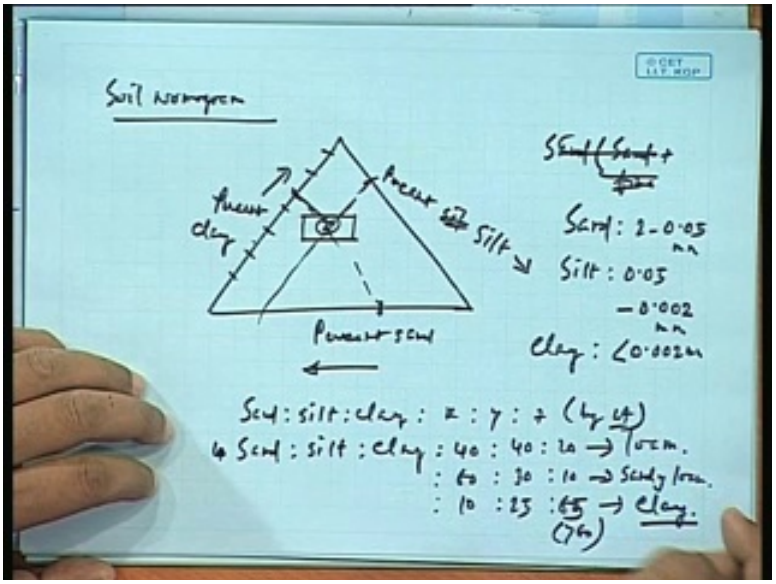

This one is, this one is you know the direction is like this, this is like this and this one is like this. So, you know you can see this so for say you know if say if we have identified that sand silt and clay, the sand silt and clay, so in such cases the sand, silt and clay that mostly the fine percent you know the sand would be included, the sand, sand is, the sand plus, plus a fine sand. Now, here the distinction is this. Remember this sand would mean anything between 2 to 0.5 please other than what has given to you, please take this this is what is also very important, particularly to use this nomogram. This is 0.05 to 0.002 mm and clay, clay remains the same that is 0.002 mm. So, what you do is you just suppose you know any kind of, any kind of sand, any kind of sand after you know you have found out the values of sand, silt and clay, suppose you have find sand, silt, clay okay the sand, silt and clay as x y and z. So, you would plot this along say you know the x here say sand here along this direction along increase direction you find x here, you find percent sand is this you find say clay to be, clay to be somewhere here and silt to be somewhere like this you know silt to be, silts to be somewhat like this.

So, you know if you just plot it like this, if you just plot it like this right, so you would parallel to this, parallel to this line if you just can draw it like this is parallel to this line wherever you know almost closely wherever they meet, this would give you the particular classification of the soil. This will give you the particular classification of the soil. For example, for example if soil is you know 40% sand, silt and clay, sand, silt and clay if it is say, if it is say composed of 40% sand, 40% sand, 40% silt and 20% clay, 20% clay, this would be known as loam, loam. Similarly, if it is 60%, 60%, 30% and 10% it would be known as, it would be known as sandy loam. Soil with 60%, if the soil is 60% or more clay say where it is 60% or say you say 65%, 65%, more than 60%, more than 60%, more than 60% say this one is 10% and say this one is 25% like this okay.

You find this one would be just be known as clay, just be known as clay. This is the textural classification, this would just be known as, the texture wise it would be known as loam, sandy loam, clay like this okay. So, this is what is the soil texture. So, you know you would be using this, you need to use this classification of the soil. What you have to remember is you know you would draw a line parallel to this line here, you would draw a line parallel to this line here and then wherever this three lines meet, the wherever three lines quite closely meet in a particular region that they show, it would not necessarily meet at one point, the region that it shows is essentially, the region it would near about show would be the region of its texture classification, okay. Sir, what is the scale on that line? This scale is you know the percent clay, say this percent clay is percentage, this is percentage. So, total is 100%, total by weight, by weight essentially by weight, yes always by weight because you know this is being a solid substance, so you know it would be always by weight, okay. So, you can write by weight, by weight as well. So, you know here this is what is called the soil texture but more important than this, more important than this soil texture is the soil structure, more important than this is soil structure.

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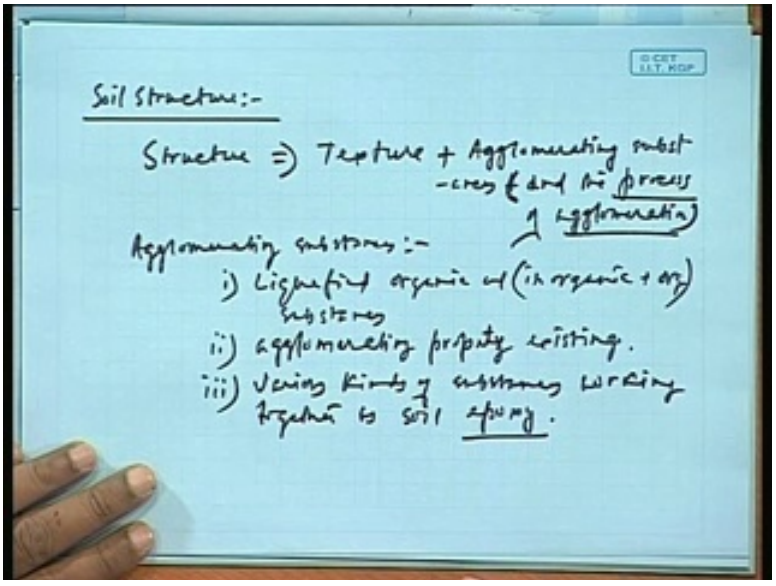

Here is the most important part, the soil structure. If you just you know structure can be, can be called as structure, can be called as texture, texture plus the agglomerating, agglomerating substances, agglomerating substances and agglomeration substances and the process, and the

process of agglomeration and the process of agglomeration and the process of agglomeration. This is process of agglomeration is important should be identified together that should be identified together, the process of agglomeration should be identified together. Why, what is generally observed this is what is that, this should generally means structure, inclusive of texture what is agglomerating to that see if there are loosen particles, when you are this is a soil as we have done in the texture measurement of texture different agglomerating distribution these are particles separate that is how we consider but if you just observe the particles being together in an agglomerated stage that is what is the texture of the soil.

So, this is a texture, this is the structure of the soil. The structure of the soil that you know we will be finding the structure of the soil this is mostly this is, so here you know the different kinds of see this agglomerating substances we have discussed about that sand, silt and clay, the most of this particles you know we'll come back to that you know what are the particles all about but these agglomerating substances are of great importance. This agglomerating substances, agglomerating, agglomerating substances are mostly liquefied, liquefied, organic, organic and inorganic plus organic substances, substances they have another important property, they have an agglomerating, agglomerating property, agglomerating property existing. So, most of this agglomerating properties they would also has agglomeration apart from agglomeration properties you know they would have say they would also provide a different types of structure just because of property right, okay. Agglomerating property existing and secondly this various, various kinds of substances working together as soil epoxy, soil epoxy, you know the epoxy is the agglomeration or thus the gum that it works with. So, all this loosen when, loosen their texture when they are agglomerated together they are structure, they are structure.

So, what happens is you know in the case of disturbance, in the case of disturbance of the soil suppose if you are picking the soil, if you are shoveling the soil like in such cases what happens is these agglomerating substances are very sensitive substances. They are, they are remaining in an organic inorganic matrix you know very closely held together right. Now as soon as these are highly prone to oxidation as well, they are highly prone to oxidation and whenever they are oxidizing, they are becoming soluble. So what happens if you are disturbing the soil, this substances begin to oxidize themselves first and then when they are oxidizing themselves, they are, they are coming out of the matrix as a substance which is soluble, readily soluble in water.

Now as soon as the rain falls on top of that, rain falls on top of that those with the rain they become soluble and go out of the soil, go out of the soil. This does not take place in the most of the soil surfaces, undisturbed soil surfaces largely because, undisturbed soil surfaces largely because they this the water, water can percolate in the soil but the material in the soil is not oxidized, the material itself in the soil is not destructured, so the agglomeration property remains intact under undisturbed condition but in disturbed condition, this agglomerating properties begin to go away, the agglomerating, the agglomerating substances begin to oxidized, begin to get oxidized and become perfectly soluble to water, perfectly soluble to water under normal temperature, pressure under STP and so they go out of the soil. So, the soil gets out of its structure, soil gets out of its structure. So, you know these are, these are the structure the most important structures that we generally talk of, the most important structures that we generally talk of. Let me give you some idea about these structures, so this is how the structures look like. This is called a granular structure, granular structure right.

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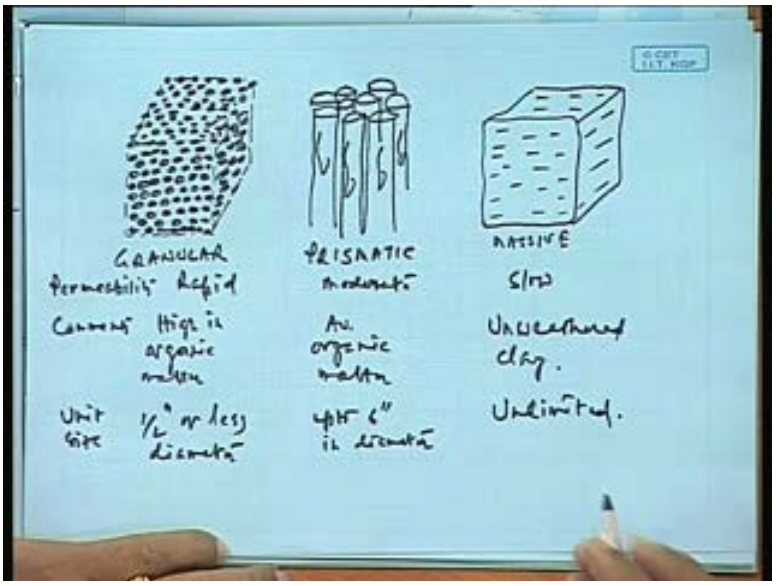

The next one is the prismatic structure we see here it looks like a prism. So, you can see this is prismatic, prismatic structure okay whereas you know where the granulars are not generally observed I mean it looks like as if it is almost a rock, you know the grains are not generally very clearly visible, this grains are not very clearly visible is that you know this is the soil, the grains cannot be identified. This is particularly, this is what is known as the massive structure, massive structure. So, here you know some properties that we can very well write out that here is this permeability if you just try to observe this permeability, permeability then this is permeability and comments say the another usual comments you know the comments. This permeability and comments you can see this you know this is high, highly permeable, high rapid permeability they call it are rapid or high as you can write but you know generally high in, high in organic matter, high in organic matter.

The prismatic soil is the permeability is moderate, a permeability is moderate and average organic matter I mean almost usually existent average organic matter and if you just see massive is very slow, so you know it's a very low or slow as you can say low permeability. This is more of a field type the characterization rapid slow is this as you can see the massive becoming slow. So, here and this particularly in the massive and unstructured, unweathered clay, this is unweathered clay, if it is unweathered clay this would look like this, the unweathered clay would look like this. Unit size if you can write out this one generally in a agriculture you know there are so some many still they are, they use a lot of a system yet inch, pound are all very much still in use that you know just see if just for your purpose here up to 6 inch in diameter and this one is up to 6 inches is unlimited, unlimited. Unlimited means you know when still would be not unlimited as within the soil, within the soil mostly the gravel would be less, so you know say unlimited may be say to the particularly it's a 2 mm that we have discussed. So, this would be, this is what is there the typical structures that we generally observe in the soil.

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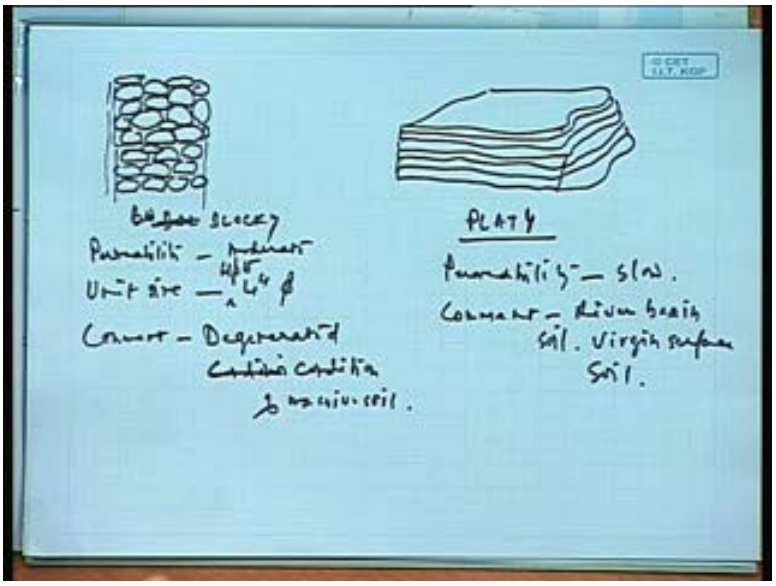

There are few more, this is more which is you know the blocky one, the blocky is nothing you know is of small, the small, a large larger particles, larger particles like a relatively you know a larger than the granular size up to about say you know as you can see compared to granular, compared to granular permeability should be high, permeability should be, permeability moderate, unit size unit size would be about say 4 inch up to 4 inch diameter up to, up to 4 inch diameter and this is what is you know this other things are like the comments that can be made, the comments that can be made is you know it is a process you know the comment you can write is degenerated condition of, degenerated condition of massive soil.

Sometimes this can be another kind of soil that we generally see which is looks like a plate, which is looking like a plate like this you know platy soil particularly in the river basins you will find this kind of soil okay. So, this is called platy. This is as I have said blocky, blocky, this one is platy, you can see permeability is, permeability should be low, permeability is mostly is very slow permeability that you know unit size is, unit size is inconsequential you know it doesn't matter because it looks like plane is an occurrence you know comment, river basin soil say, so this is virgin surface soil, virgin surface soil. So, you know you can find them in the virgin surface soil, so this is what is the platy structure of the soil.

So, we can find that you know the soils can come in different you know structures and this structure is all important about soil is extremely important I mean if the soil structure is maintained. And remember one thing to bring back to the soil structure, to bring back to the soil structure is extremely difficult. I mean once it is destructed, once it is destructed you can think of say once this is destructed all these things are destructed I mean generally what happens in an engineering construction, dam construction, road construction, building construction wherever in a mining activity is when you are disturbing this completely destroying this to bring it back to a certain structure is extremely difficult and that is what remains the most important activity of soil reclamation to bring it back to a certain structures. So, that the structure is all important because the structure is which would help them to keep the nutrients within the soil, would help them to

keep the soil water in them, would also help the soil to hold on to the plants, so that the plants do not fall off, the plants can stand on its own. So, this is, these are the structure remains the most important part of, structure remains the most important part of soil I mean if the structure is destroyed much of the soil is destroyed, destroyed. So, having said this you know this is another important thing that we will discuss is just one minute, few minutes on this.

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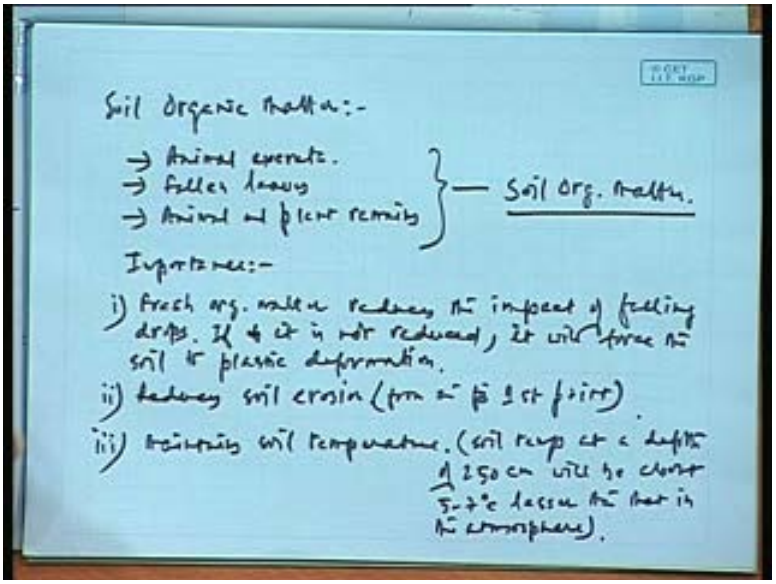

The soil, the soil organic matter, the soil organic matter, the soil organic matter that we see is a soil organic matter have, also has a lot of things to discuss you know the soil organic matter, the basic purpose of the soil organic matter. This is particularly composed of say composed of animal excreta, excreta, falling leaves, fallen leaves, fallen leaves then this particularly the remains animal and plants remain, plant remains, animal and plant remains contribute to the soil organic matter, soil, soil organic matter, so soil, soil organic matter. The soil organic matter the purpose you know this we'll come back to this characteristic of the soil organic matter, we will come back to this soil, purpose of the soil organic matter but before that let me explain you know what are the important effects, what are, why this soil organic matter is extremely important, soil organic matter importance.

If you think of the importance you know this fresh organic matter, matter reduces the impact of, impact of falling rain drops, impact of falling rain drops. Falling rain drops you know if this impact, if the, if they if it is not reduced, if it is not reduced it will force the soil to plastic deformation, to plastic deformation it would allow this the soil to force the plastic deformation as a result of which the water would be, the soil would be destabilized. The soil would be when disengaged from the parent body, the soil would be disengaged from the parent body, so reduces soil erosion.

So, from the first you can see, from the first point, from the first point we can derive this that the second point. The third one is maintains soil temperature, maintain soil temperature, maintain soil temperature. Soil temperature as we have said you know I have said the soil temperature

becomes extremely important you know maintaining soil temperature you know in many cases the outside the difference from the outside temperature to the soil temperature say soil temperature, soil temperature at say, at say, at a depth of 250 centimeter, 250 centimeter soil temperature at a depth, at a depth of 250 will be about 5 to 7 degree centigrade lesser than that in the atmosphere. And this one is, this one is particularly very critical it becomes particularly very critical 5 to 7 degree less from the surface temperature same think of this. So, in a hot summer when the temperature outside would be 45 degree centigrade, you have the soil the plant roots are finding all the substances at a temperature of say 40 degree centigrade that makes a lot of difference, that makes a great number of differences.

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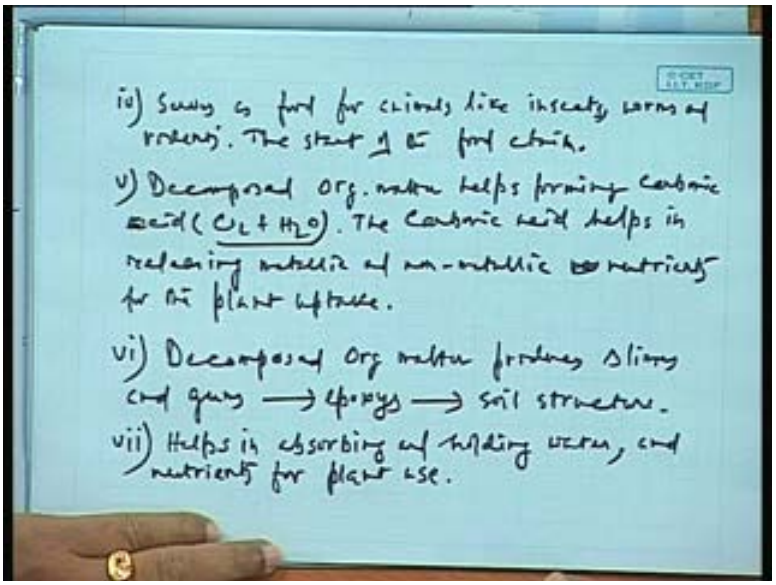

It also you know this is serves as food for animals, animals like, animals like insects, insects, worms and rodents. So, you can, you can see the early, the start of, start of the food chain, the start of the food chain, the start of the food chain is of great role of great importance. This is where its starts the food chain. This is the fifth point is say this also decomposed, decomposed, decomposed organic matter, decomposed organic matter helps forming carbonic acid that is CO 2 plus H 2 O carbonic acid, there the carbonic acid, carbonic acid releases, carbonic acid helps in releasing metallic and non-metallic nutrients decomposed organic matter helps forming carbonic acid, the carbonic acid helps in releasing metallic and non-metallic nutrients that is you know carbonic acid forming you know in the reactions that you know many of those substances would be, would be ionized, many of this substances say the substances that we require the phosphorous, boron, calcium, magnesium, iron, phosphorous all these are that are required generally being, being released, being released in the soil environment by the carbonic acid, with the help of this carbonic acids. So this is metallic nutrients for the plant up take, for the plant up take.

The sixth point is the decomposed organic matter, decomposed organic matter produces slims, slims and gums. This is what are the, this is what form the epoxy's, the soil epoxy's or the soil you know the soil epoxy's or the agglomerating substances this what leads to the soil structure.

This helps in maintaining the soil structure or evolving a soil structure also by which the soil structure would be evolved. So, maintaining and evolving soil structure, maintaining and evolving soil structure. It maintains the soil structure it also you know if it is, the soil is disturbed, suppose you know where the soil is being dumped at one place the evolution of the structure, the soil evolves the evolution of the structure is held by the soil structure also. Evolution of the soil structure is laid by the decomposed organic products, organic material. This is, the last point here is you know the organic matter is this helps in absorbing and holding, absorbing and holding, absorbing and holding water, absorb helps in absorbing and holding water and nutrients and nutrients for plant use.

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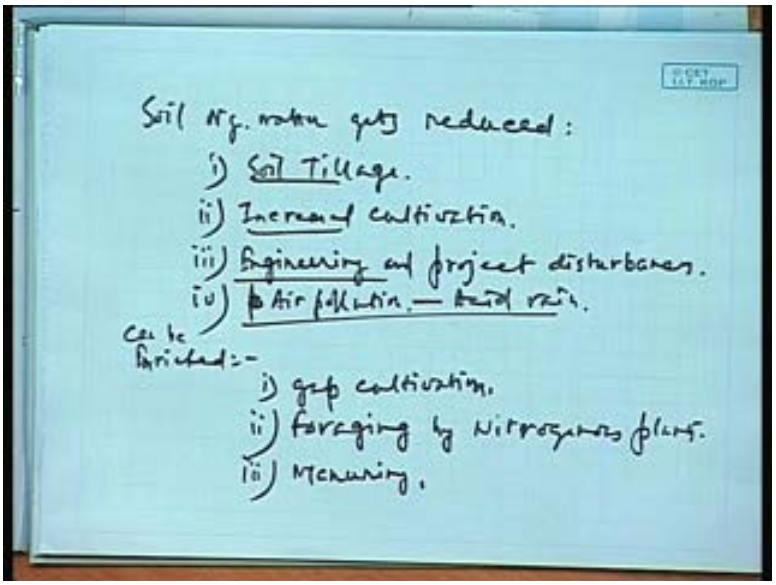

So, what is this is organic matter say you know in an engineering aspect if you say the, how this soil, soil organic matter gets, the soil organic matter gets reduced by soil tillage, by soil tillage increased cultivation, increased cultivation, engineering and project disturbances, engineering and project disturbances and engineering and project disturbances and so engineering and project disturbances and also pollution say here and so reducing due to say increased air pollution. If you remember in the acid rain that we did acid rain, acid rain is another important reason why this soil organic matter gets reduced and this if this soil organic matter gets reduced the, it is, it can be enriched, enriched by a gap cultivation, gap cultivation then foraging say foraging by say nitrogenous plants, nitrogenous plants and also by manuring, also by manuring, also by, can be enriched, can be enriched gap cultivation foraging by nitrogenous plants and manuring, using manuring of fertilizers, organic fertilizers, organic fertilizers. So, you know you can see this you know this is how the soil you know this is the important characteristics of the soil you know how they have a role to play, for what great role they play. So, all this things gets destructed whenever there is major soil disturbance, whenever there is a major soil disturbance okay. We will take up this again, we will take up this again related to soil again in the next class.

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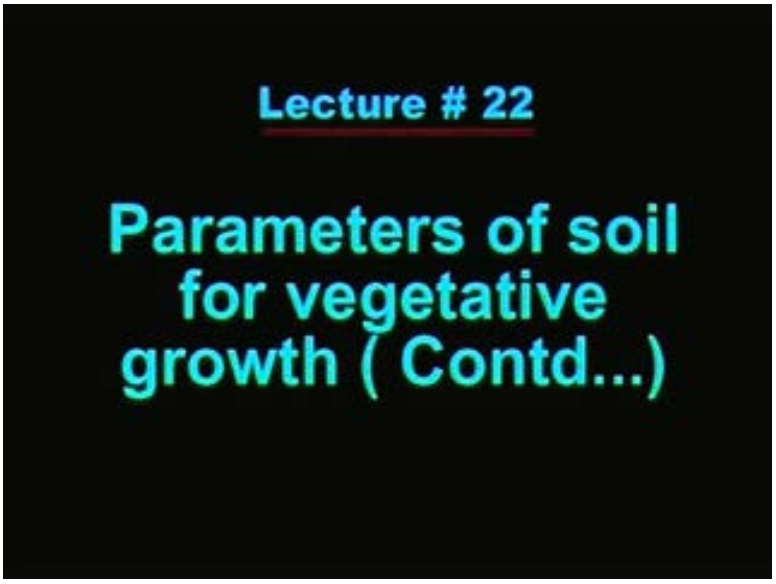

Okay, so we will begin this class today with this you know the other parameter that are important for vegetative growth. So, what we started you know what we have talked so far about this soil organic matter?

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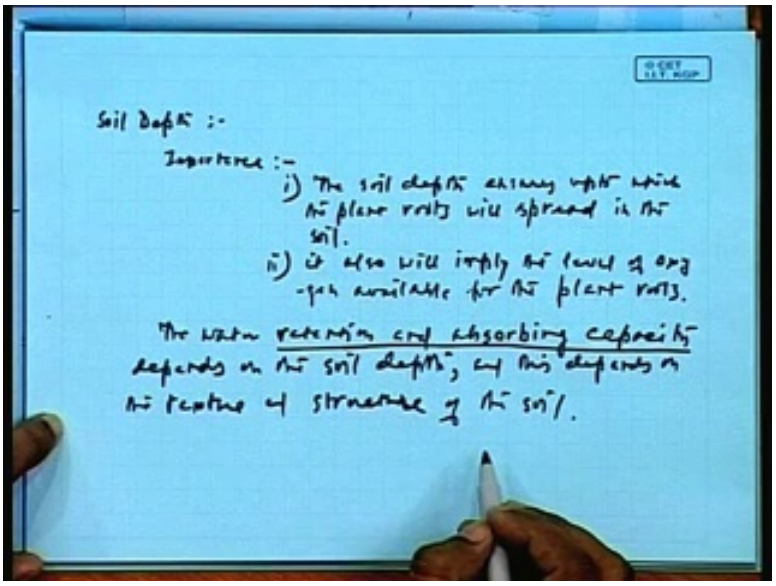

Now we will come to soil depth. There is another important parameter the soil depth. The soil depth serves you know in two, two ways, the importance of soil depth, importance, importance as we can see for this soil depth, the first of all that soil depth ensures up to which the plant roots will spread 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 plant 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 depends and these depends on the texture and these whole thing, this whole retention and absorbing capacity this depends on the texture and structure of the soil. 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 polysaccharides is a structurally is a polysaccharides this is and is composed of these three, these three acids you know fulvic acid, humic acid and humin acid.

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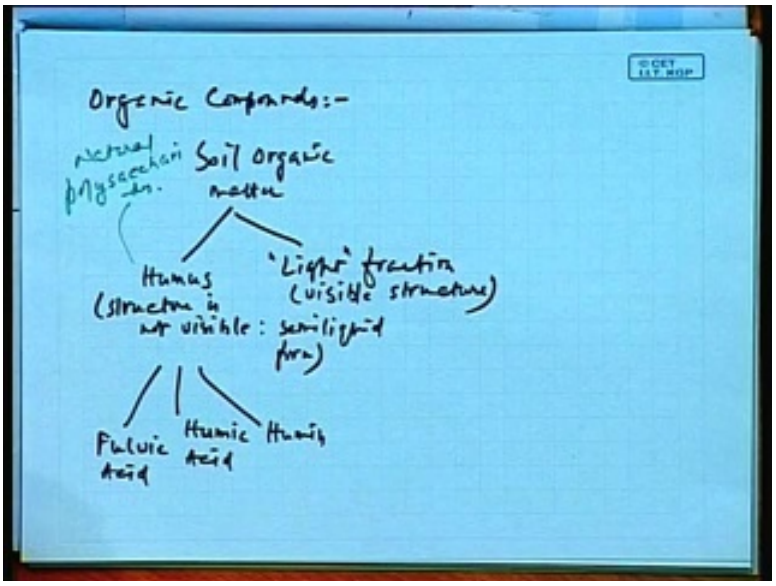

So, this is remember one thing, this is, this is not a single acid okay, this is the family of acids. All these are basically family of acids. This is, these are all family of acids you know there are fulvic acid, there may be a different number of species available in fulvic acid, number of species 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 this is what you know if you are just for our purpose, for our engineering purpose what is a, I mean general a constituent of an organic. Suppose, if you are going to use an organic fertilizer in the soil, see 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 will 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, the radical phenolic, phenolic OH.

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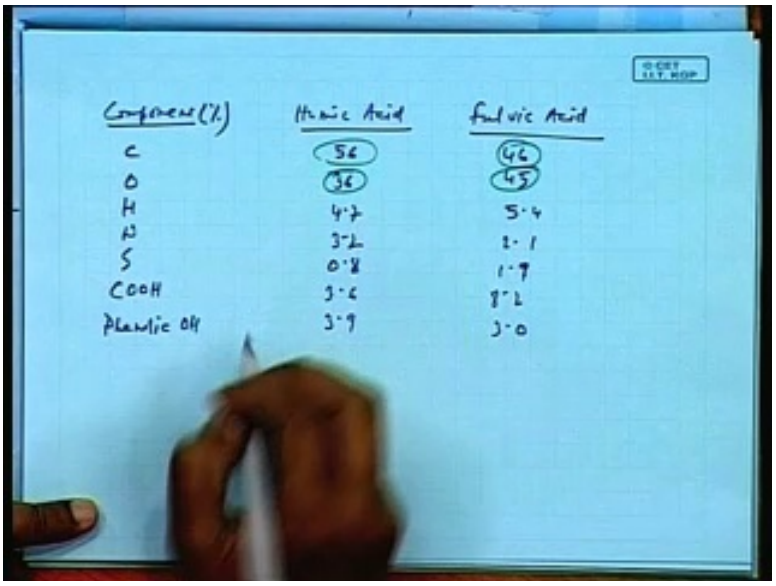

So, here in humic acid you know this is 56, 36, 4.7, 3.2, 0.8, 3.6 and 3.9 whereas this one is fulvic acid here we can see is 46, 45, 54, 5.4 then 2.1, 1.9, 1.9, 8.2. Just you know, just to give an idea, just to give an, give an idea about the chemical composition of this acids. So, you know here you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