Soil Science and Technology
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Lecture – 28
Soil Acidity

Welcome, friends to this new lecture of week 6 that is we will start from Soil Acidity. So, basically will be starting for you know discuss discussion about the different types of problematic soil. So, we are starting with the soil acidity now. So, soil acidity is very very important as per as the soil physical chemical and biological properties are concerned.

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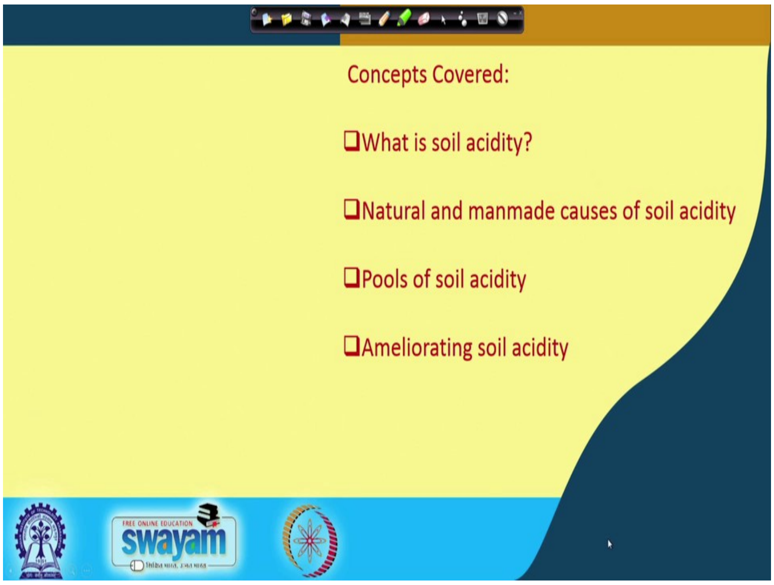

Concepts Covered:

- ☐What is soil acidity?
- ☐Natural and manmade causes of soil acidity
- ☐Pools of soil acidity
- ☐Ameliorating soil acidity

And, we will be covering this following concepts will be recovering what is first soil acidity and then what are the natural and manmade causes of soil acidity, what are the different pools of soil acidity and finally, how to ameliorate soil acidity. Obviously, you know we cannot cover in details all of this, we will be having a you know will be trying to give you a snapshot of different ideas and overview of different you know of this topics and will hope that you will learn in details in future by consulting different textbooks and reference books.

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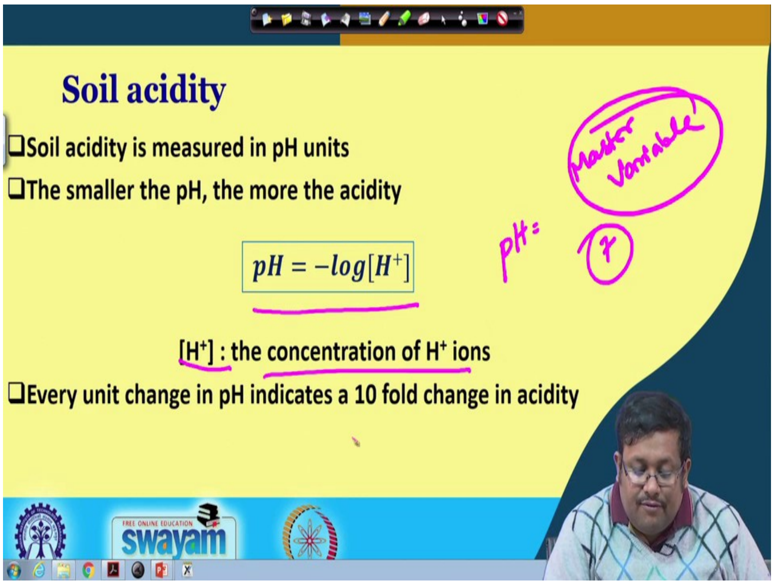

Soil acidity

☐Soil acidity is measured in pH units

☐The smaller the pH, the more the acidity

$$pH = -log[H^+]$$

$[H^+]$: the concentration of H^+ ions

☐Every unit change in pH indicates a 10 fold change in acidity

So, we just start with the soil acidity. Obviously, you know soil acidity is measured in pH units and you know that pH is basically the negative logarithm of hydrogen ion concentration and it also considered as a master variable ah. So, let me increase the mouse pointer so, that minute please so ok, alright. So, you know that pH is basically the negative logarithm of hydrogen ion concentration and it varies from you know the pH varies from 0 to 14 and obviously when the pH is, when the pH is 7 that is called neutral and when it is greater than 7 that is call you know alkaline conditions and when there is a less than 7 pH that is a acidic condition.

So, pH is also known as the master variable as per as the soil analysis is concerned because it governs different types of soil chemical, physical and biological activities. Different microorganisms are present in the soil based on the soil pH and their abundance varies from one pH condition to another pH condition. Different chemical processes and biological processes and nutrients recycling processes and nutrient mobility and nutrient I would say nutrient transformation processes specifically depends on the soil pH. So, that is why it is called master variable and obviously, you know here the pH is the negative log of hydrogen ion concentration where this H is the concentration of you know protons or H plus ions and remember that every unit change in pH indicates 10 fold changes in acidity, obviously.

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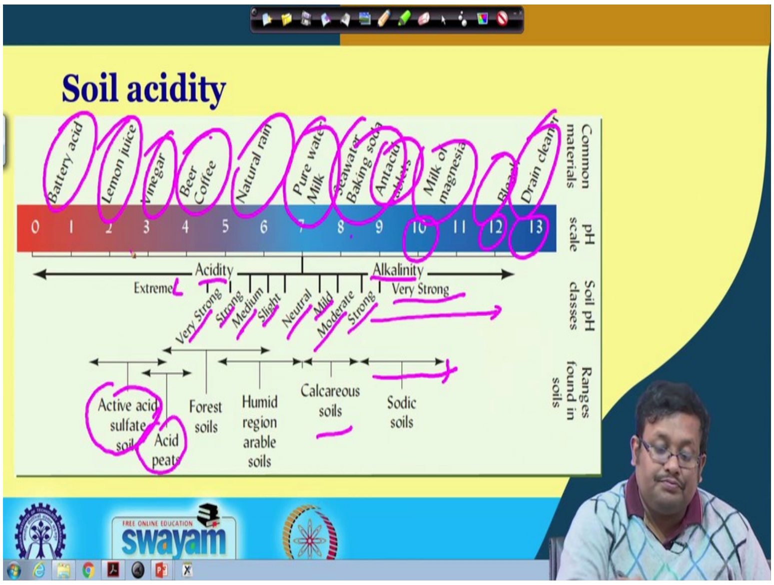

Soil acidity

So, let us move forward and see the different grades of soil acidity. So, you can see the soil acidity varies from 0 to generally 14 and obviously, beyond the beyond the pH 7 it is called alkaline soil and in case of less than 7, it is called acidic soil also we call it soil acidity. Extreme level of soil acidity can be found when the soil pH goes below 4 an extreme level of very strong level of soil alkalinity found when the soil pH goes you know greater than 8 greater than 8 or something like that.

So, depending on the soil acidity also we divided the you know ranges you know we define a different types of soils. You know this extreme level of the soil acidity can be found in case of acid sulphate active acid sulphate soil and this type of acid sulphate soil you know having you know very low pH sometime 3 and less than 3 at this type of acid sulphate soil is also available is basically in India we can see this type of acid sulphate soil in Kerala.

And, also the acid peats are having very low pH and the forest soils; the forest soils having the also very low pH that is almost from 3 to 6. And, humid region arable soil generally have the pH varies from 5 to near neutral condition and in case of calcareous soil they have the pH starting from generally slightly alkaline to strongly alkaline soils and sodic soils are having strong alkalinity. Sodic soils are generally dominated by sodium ions whereas, calcareous soils are generally dominated by calcium ions.

So, you can see depends on the you know soil pH classes also divided into the very strong that is less than 5 and then strong that is around 5 to 6 medium, then slight, neutral condition generally around 7 and then 7.5 is mild moderate is generally 8 and beyond 8 or 9 it is strong and very strong. So, these are also very important.

So, what are the reason you know what are the similarity between this pH levels with different types of common materials? Obviously, pH 0 you will see the in case of battery acid, in case of lemon juice you will find pH of 1 to 2 around, for vinegar it is pH 3, for beer or coffee will get pH 4, in case of natural rain will have pH of 5, in case of pure water milk these are neutral in reaction. So, we will have around 7; sea water, baking soda will have around 8, antacid tablets will have 9 and then milk of magnesia is basically having the pH of 10 and bleach will have the pH of 12 where as the drain cleaner will have the pH of 13.

So, you can see different chemicals which shows different ranges or different pH condition and you know will get the extreme conditions in case of battery acid as well as in case of drain cleaner, so a common materials and their respective pH. So, this graph basically gives a basic overview of how pH varies and what are the different classes of pH and what type of soil pH ranges you can expect in different types of soil like sodic soil, then calcareous soil, then humid region arable soils and forest soils, acid peats soils and active you know acid sulphate soils.

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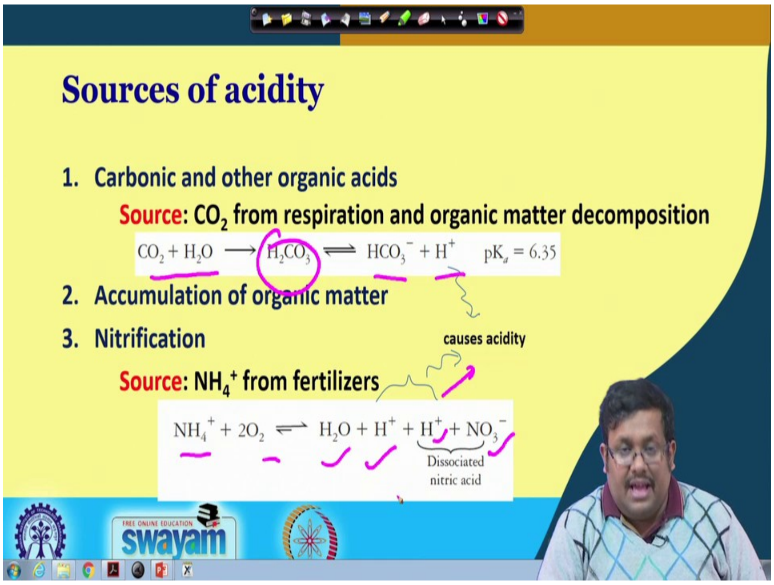

Sources of acidity

1. Carbonic and other organic acids

   Source: CO_2 from respiration and organic matter decomposition

   $CO_2 + H_2O \longrightarrow H_2CO_3 \rightleftharpoons HCO_3^- + H^+ \quad pK_a = 6.35$

2. Accumulation of organic matter
3. Nitrification

   Source: NH_4^+ from fertilizers

   $NH_4^+ + 2O_2 \rightleftharpoons H_2O + H^+ + \underbrace{H^+ + NO_3^-}_{\text{Dissociated nitric acid}}$

So, let us move ahead and see: what are the different sources of soil acidity. Obviously, the first and foremost source of soil acidity is a carbonic and other organic acids. Remember that in case of soil here the soil air contains high carbon dioxide concentration due to and you know from respiration or organic matter decomposition and this carbonic acid basically you know it reacts with water to form this carbonic acid and this carbonic acid further dissociates to form this bicarbonate anion and protons and this protons basically causes the acidity.

And, further accumulation of organic matter, obviously, this organic matter when there will be high amount of organic matter accumulation this will be decompose you know eventually those will decompose and due to the decomposition process of organic matter they will increase the soil acidity. For third is the nitrification process will discuss the nitrification process in details when will be you know will be discussing soil nitrogen in week 7.

And, so, nitrification is you know is basically the conversion of ammonium forms of nitrogen to nitric form. So, due to this and it is an oxidation process and you can see here ammonium getting oxidised to form water, proton and disassociated nitric acid that is H plus and NO_3 minus and these H plus or protons will basically causes the acidity. Remember there is this nitrification is basically a microbial mediated you know reaction. So, this nitrification ultimately forms these protons and these protons will ultimately add to the acidity of the soil. So, this nitrification is a acid generating reaction or process. So, what are the other process of soil acidity?

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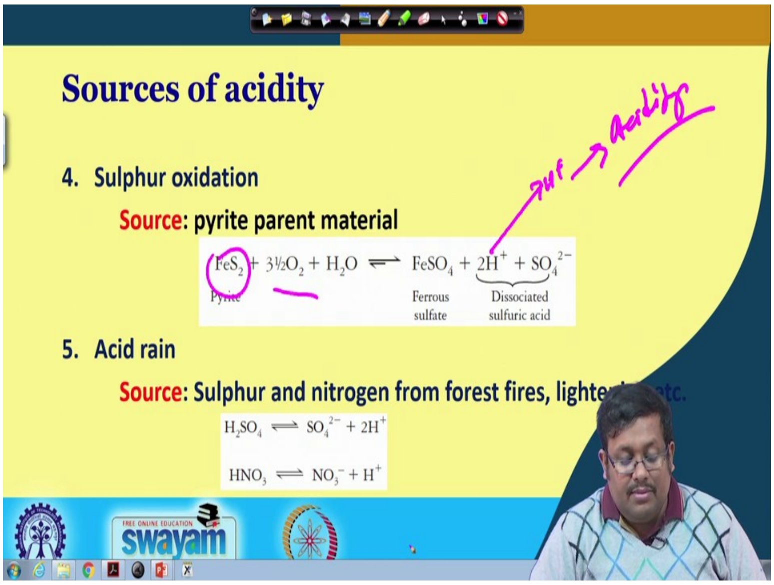

Sources of acidity

4. Sulphur oxidation

Source: pyrite parent material

$$\underset{\text{Pyrite}}{FeS_2} + 3½O_2 + H_2O \rightleftharpoons \underset{\text{Ferrous sulfate}}{FeSO_4} + \underbrace{2H^+ + SO_4^{2-}}_{\text{Dissociated sulfuric acid}}$$

5. Acid rain

Source: Sulphur and nitrogen from forest fires, lighte etc.

$$H_2SO_4 \rightleftharpoons SO_4^{2-} + 2H^+$$

$$HNO_3 \rightleftharpoons NO_3^- + H^+$$

Soil acidity: so, sulphur oxidation, sometime pyrite parent material are there as we can see here you know pyrite is iron pyrite here is FeS_2 and this FeS_2 when it gets oxidized ultimately it will produce the ferrous sulphate and also dissociated sulphuric acid and this sulphuric acid will produce these H plus ions which will ultimately add to acidity of the soil. So, this is another important reaction for ah. So, sulphur oxidation is one of the major contributor of soil acidity.

And, finally, acid rain acid rain you know different due to different types of combustion of the fossil fuels, different types of forest fire and other processes when huge amount of you know sulphur dioxide and nitric oxide or nitrogen dioxide goes into the atmosphere and then they react with the atmospheric moisture atmospheric water vapour and ultimately reproduce different types of acidic you know different types of acids and these acids generally come down to the earth surface during the different types of rain raining event and we call it acid rain.

So, when the sulphur dioxide goes into the atmosphere, reacts with water vapour, forms the sulphuric acid and ultimately finally, reaches to the soil surface as a result of acid rain. This is also important source of soil acidity. Similarly happens in case of nitric acid. Now, you know in case of nitrogen dioxide and also different types of you know apart from this burning of the fossil fuels. And, you know different types of you know combustion of the fossil fuels and forest fire also you know lightning events also generate this type of gases and ultimately produces this acid rain as you can see here H_2SO_4 when it reaches it disassociates to form the sulphate as well as protons. And, also the nitric acid disassociates to form nitrate and H plus and this H plus you know this ultimately forms the soil acidity; sources of the important sources of soil acidity.

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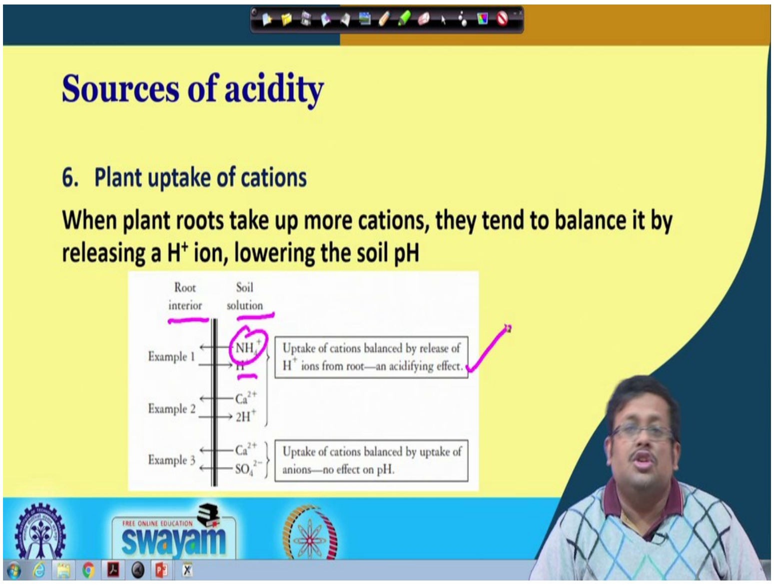

Sources of acidity

6. Plant uptake of cations

When plant roots take up more cations, they tend to balance it by releasing a H^+ ion, lowering the soil pH

So, plant uptake of the cations is another important aspect when plant root takes up the more cations you know they tend to balance it by releasing the H plus ion and lowering the soil pH. So, as you can see here this is a root interior and soil solution and in case of this first example; obviously, the plant is trying to uptake the ammonium and as a result of the uptake of the ammonium which is a positive cation, it want to counter balance, it want to balance this uptake by release of these H plus ions from the root and it is called the acidifying agent.

So, this another reason this another cause of soil acidity.

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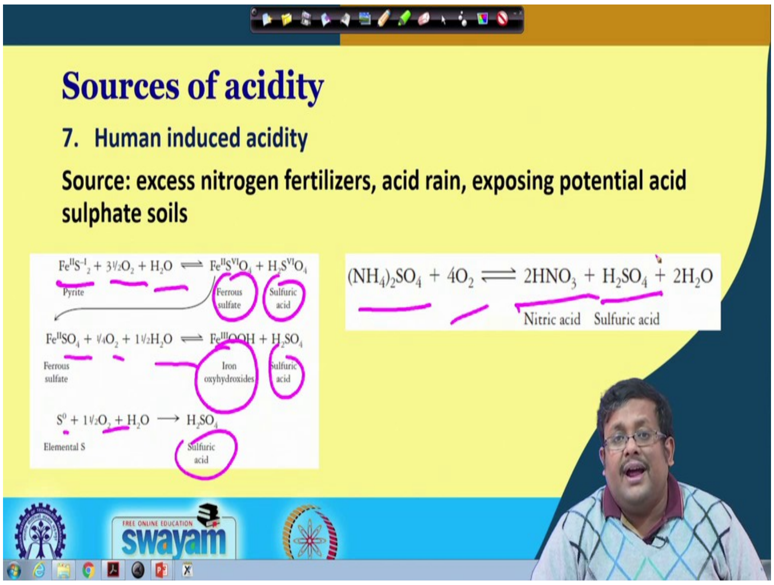

Sources of acidity

7. Human induced acidity

Source: excess nitrogen fertilizers, acid rain, exposing potential acid sulphate soils

$Fe^{II}S^{-I}_2 + 3\frac{1}{2}O_2 + H_2O \rightleftharpoons Fe^{II}S^{VI}O_4 + H_2S^{VI}O_4$

Pyrite; Ferrous sulfate; Sulfuric acid

$Fe^{II}SO_4 + \frac{1}{4}O_2 + 1\frac{1}{2}H_2O \rightleftharpoons Fe^{III}OOH + H_2SO_4$

Ferrous sulfate; Iron oxyhydroxides; Sulfuric acid

$S^0 + 1\frac{1}{2}O_2 + H_2O \longrightarrow H_2SO_4$

Elemental S; Sulfuric acid

$(NH_4)_2SO_4 + 4O_2 \rightleftharpoons 2HNO_3 + H_2SO_4 + 2H_2O$

Nitric acid; Sulfuric acid

So, another important cause of soil acidity is human induced acidity and obviously, excess of nitrogen fertilizer, then acid rain, exposing potential acid sulphate soil are all these are basically anthropogenic in nature. For example, when we use you know excessive amount of nitrogen fertilizer that also ultimately forms the nitrification process and this nitrification process generates this you know acids and also acid rain the burning of the fossil fuel it is an human driven process and exposing potential acid sulphate soil which get completely oxidised to form the more acidity. So, these are the sources of the acidity.

As we can see here obviously, pyrite is getting oxidised to form this ferrous sulphate and sulphuric acid, and this ferrous sulphate is further oxidised to form the iron oxyhydroxide and further sulphuric acid, an elemental sulphur also get oxidised sometime to get the sulphuric acid. So, all of these are human induced processes and these human induced processes ultimately leads towards building of soil acidity and sometime it is very very harmful for soil biological you know different types of soil microorganism and macro organisms as well as different types of soil chemical process.

And, also you can see here the ammonium sulphate it is a important nitrogens you know fertilizer when it get oxidised and ultimately form the nitric acid and sulphuric acid these also you know adds up to the acidity of the soil.

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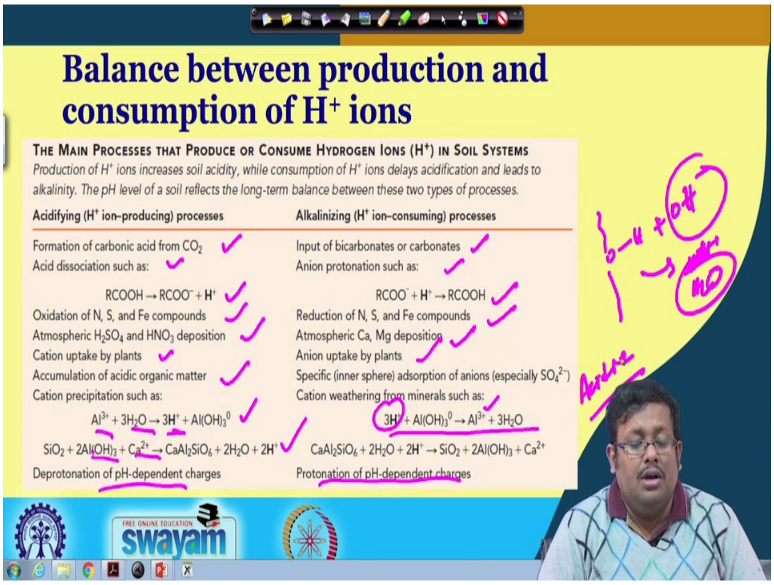

Balance between production and consumption of H⁺ ions

THE MAIN PROCESSES THAT PRODUCE OR CONSUME HYDROGEN IONS (H^+) IN SOIL SYSTEMS

Production of H^+ ions increases soil acidity, while consumption of H^+ ions delays acidification and leads to alkalinity. The pH level of a soil reflects the long-term balance between these two types of processes.

Acidifying (H^+ ion–producing) processes	Alkalinizing (H^+ ion–consuming) processes
Formation of carbonic acid from CO_2	Input of bicarbonates or carbonates
Acid dissociation such as:	Anion protonation such as:
$RCOOH \rightarrow RCOO^- + H^+$	$RCOO^- + H^+ \rightarrow RCOOH$
Oxidation of N, S, and Fe compounds	Reduction of N, S, and Fe compounds
Atmospheric H_2SO_4 and HNO_3 deposition	Atmospheric Ca, Mg deposition
Cation uptake by plants	Anion uptake by plants
Accumulation of acidic organic matter	Specific (inner sphere) adsorption of anions (especially SO_4^{2-})
Cation precipitation such as:	Cation weathering from minerals such as:
$Al^{3+} + 3H_2O \rightarrow 3H^+ + Al(OH)_3^0$	$3H^+ + Al(OH)_3^0 \rightarrow Al^{3+} + 3H_2O$
$SiO_2 + 2Al(OH)_3 + Ca^{2+} \rightarrow CaAl_2SiO_6 + 2H_2O + 2H^+$	$CaAl_2SiO_6 + 2H_2O + 2H^+ \rightarrow SiO_2 + 2Al(OH)_3 + Ca^{2+}$
Deprotonation of pH-dependent charges	Protonation of pH-dependent charges

So, let us move ahead and see what are the how the balance between production and consumption of H plus ions are maintained. So, here you can see the main process that produces or consume hydrogen ions in soil systems are given. So, acidifying or H plus ion producing process are given here. Obviously, the formation of carbonic acid from carbon dioxide you know that, due to the you know due to the at these carbon dioxide basically generates due to the respiration action of microorganisms. Acid dissolution such as you know you know RC double O H and you can see the dissolution of the acid will further disassociates disassociates. Dissociation of the acids which further produces the H plus ion.

Then, oxidation of N, S and Fe compound we already showed you and you know atmospheric H_2SO_4, HNO_3 deposition in the form of acid rain. Cation uptake by the plants I showed you. Accumulation of acidic organic matter and then cation precipitation such as you know you can see aluminium when reacts with water to form this aluminium hydroxide and also generates 3 hydrogen or you know three 3 protons which you know. So, these basically hydrolysis process and this adds up to the acidity. So, that is why aluminium is also considered as a acidic cation of the soil. So, this you know there is a common you know everybody ask why we consider aluminium for for as an acidic you know acidic cation because due to the hydrolysis process it generates the H plus ion. So, that is why we call it as an acidic cation.

And, also you can see here silica is reacting with aluminium hydroxide and calcium and you can see ultimately it is also producing the H plus ion which is acidic production. So, deprotonation of the pH dependent charges; obviously, you can see if you remember you know the pH dependent charge and pH dependent charge occurs you know you know acidified process you know if you if you remember the pH dependent charge pH dependent charge occur at the ages of the mineral like kaolinite and aluminium oxides and it is you know depending on the pH.

So, in the alkaline condition when there will be sufficient amount of hydroxyl anion these H plus will deprotonate and comes into the solution to form H_2O to form H_2O. So, it is a deprotonation process and ultimately it will add to the pH of the soil. And, alkalinizing you know alkalinizing or H plus ion consuming process are also given here inputs are bicarbonates and carbonates in the form of lime.

And, anion protonation; you can see here anion protonation. Reduction of N, S and Fe compounds it is quite obvious; atmospheric calcium, magnesium deposition, because these are basic cations. Anion uptake by the plant; obviously, when there will be anion uptake by the plant more cations will be you know released. And, the specific adsorption of anions and cation weathering from mineral such as you know 3H plus when you know aluminium hydroxide reacts with this proton to form this aluminium ion and in water molecules this is an another H plus ion consuming processes and also protonation of the pH dependent charge. So, this is opposite of this reaction.

So, in case of acidic condition; remember, in case of acidic condition protonation of the pH dependent charge occurs and in case alkaline condition deprotonation occurs. So, these are the processes for making the balance of for the production and consumption of H plus ions.

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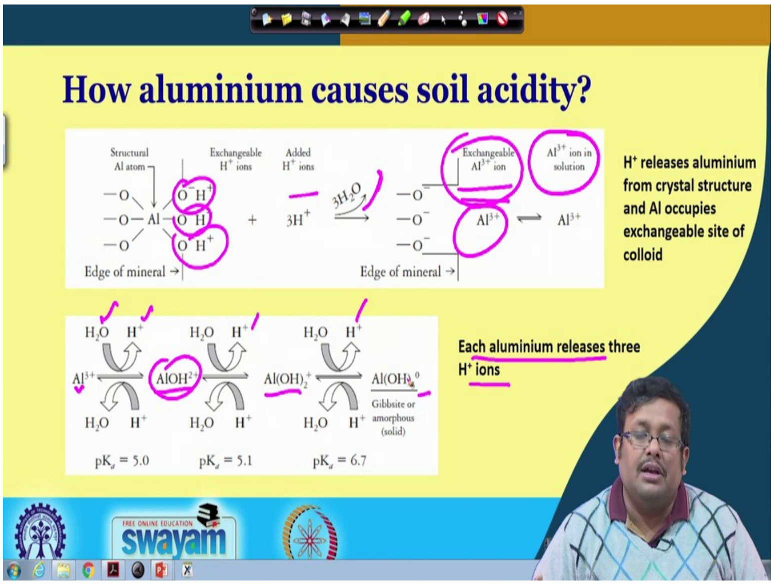

How aluminium causes soil acidity?

H^+ releases aluminium from crystal structure and Al occupies exchangeable site of colloid

Each aluminium releases three H^+ ions

So, how aluminium causes the soil acidity? Obviously, the H plus releases aluminium from crystal structure and aluminium occur. So, here you can see this important process. So, you know that aluminium is present in the crystal structure of the clay minerals and it is bound to this hydroxyl groups at the age of the mineral and when there we add you know when the you know you now added H plus ions and these H plus ions get adsorbed in to the clay surfaces it basically makes this crystal structure less stable and ultimately these three molecules of what you know three molecules of water get released ultimately you know ultimately you know releases the aluminium from this crystal structure.

And, these aluminium is you know is present ultimately at the age of the mineral as exchangeable Al_3 plus ion and these exchangeable Al_3 plus ion basically are is in you know equilibrium with the Al_3 plus ion in the solution. And, these Al_3 plus ion exchangeable Al_3 plus ion ultimately helps in hydrolysis of the water to produce the to produce the H plus ion as you can see hear this is the you know hydrolysis of the water ah. So, if you consider this process this reaction this Al_3 plus reacts with the water and ultimately produces the H plus ion producing these aluminium hydro the this compound. And, the second step it is also again you know releasing another H plus producing $Al(OH)_2$ and farther it is producing $Al (OH)_3$. So, each aluminium releases 3 H plus ion.

So, that is why the aluminium is considered as an acidic cation. So, apart from H plus aluminium is also considered as a acid cation because it produces H plus ion or acidic you know is basically producing the H plus ion due to the hydrolysis of water.

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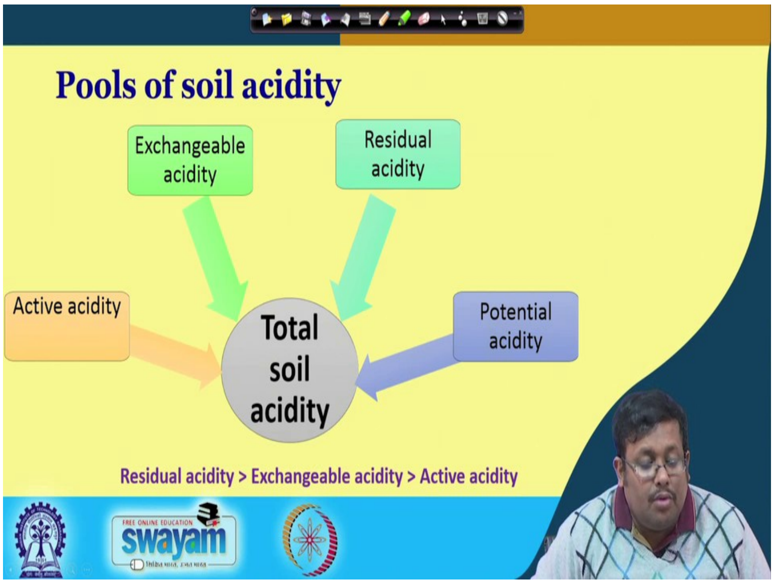

Pools of soil acidity

Exchangeable acidity

Residual acidity

Active acidity

Total soil acidity

Potential acidity

Residual acidity > Exchangeable acidity > Active acidity

So, there are different pools of soil acidity. Basically the pools of total soil acidity generally it is a combination of active acidity plus exchangeable acidity and residual acidity and there is another term called potential acidity we will we will cover at know this later.

So, active acidity exchangeable acidity and residual acidity are very important and as per the quantity wise is concerned this residual acidity is always higher than exchangeable acidity which is further higher than active acidity. So, let us see what are the active acidity, exchangeable acidity and residual acidity.

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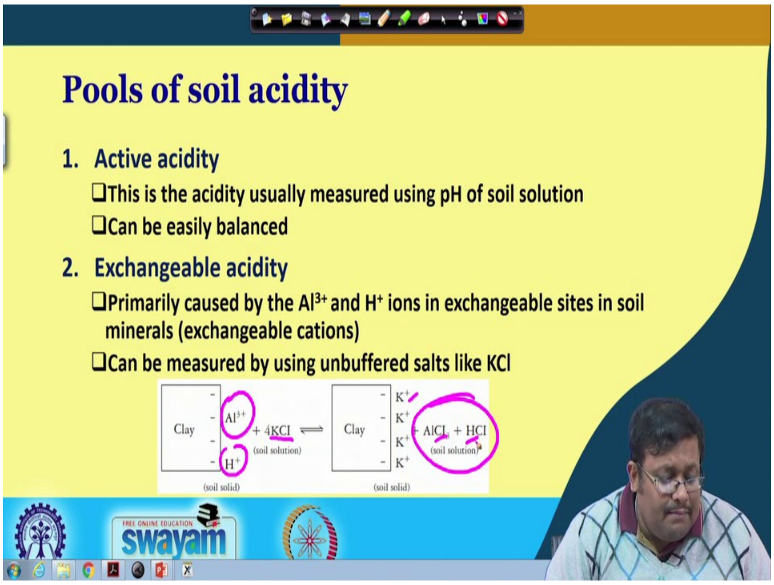

Pools of soil acidity

1. Active acidity
   - ❑This is the acidity usually measured using pH of soil solution
   - ❑Can be easily balanced
2. Exchangeable acidity
   - ❑Primarily caused by the Al^{3+} and H^+ ions in exchangeable sites in soil minerals (exchangeable cations)
   - ❑Can be measured by using unbuffered salts like KCl

So, active acidity is the acidity usually measured by using the pH of the soil solution and active acidity basically represent the H plus and concentration in the soil solution and it can be easily balanced and when we measure the pH of the soil solution by a by a pH metre basically measures the active acidity. What is exchangeable acidity? Now, exchangeable acidity primarily caused by the Al_3 and H plus ion. As you know that Al_3 also acts as acidic cation, so, when we combine the Al_3 plus plus H plus ions in the exchangeable sites in the soil mineral they are the exchangeable cation then we call it the exchangeable acidity and it can be measured by using unbuffered salt like KCl.

As you can see here in this reaction now this Al_3 plus and H plus are present in the exchangeable sites and we are you know adding some unbuffered salt like KCl which is basically replacing all the Al_3 plus and H plus ions and replaced with the K plus. So, it comes in to the soil solution. So, it can be measured then this you know aluminium and H can be measured. So, this is an example of exchangeable acidity. So, we have covered the active acidity exchangeable acidity.

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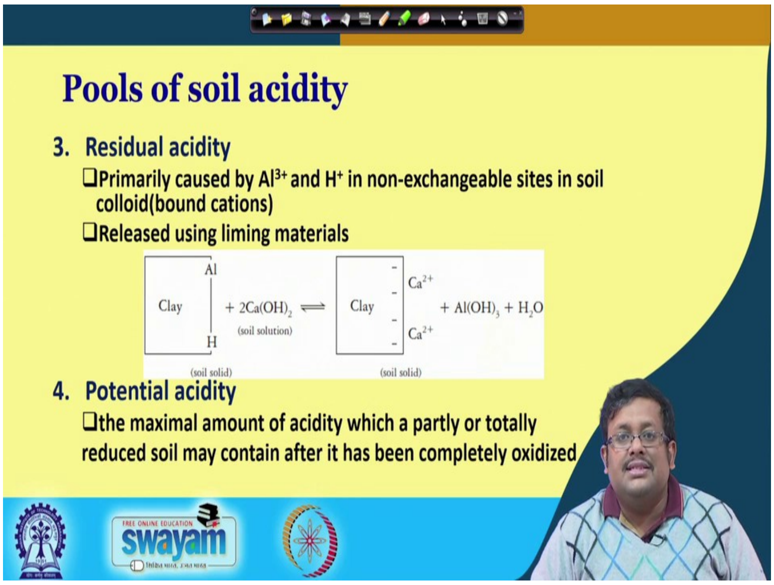

Pools of soil acidity

3. Residual acidity
   - ❑Primarily caused by Al^{3+} and H^+ in non-exchangeable sites in soil colloid(bound cations)
   - ❑Released using liming materials

$$\text{Clay}\begin{matrix}Al\\H\end{matrix} \; (\text{soil solid}) + 2Ca(OH)_2 \; (\text{soil solution}) \rightleftharpoons \text{Clay}\begin{matrix}-\;Ca^{2+}\\-\;Ca^{2+}\end{matrix} \; (\text{soil solid}) + Al(OH)_3 + H_2O$$

4. Potential acidity
   - ❑the maximal amount of acidity which a partly or totally reduced soil may contain after it has been completely oxidized

So, what is the residual acidity? Residual acidity is basically primarily caused by the Al_3 plus and H plus in non-exchangeable sites in soil colloids, basically in the clay and organic carbon organic matter. And, they are basically bound cations and released using the liming material. So, you can see these are basically non exchange present in the non -exchangeable soil and when we are adding the calcium hydroxide it is basically releasing these and producing aluminium hydroxide and replacing with the calcium. So, this is an example of residual acidity.

So, basically total acidity is the combination of residual acidity and active acidity and exchangeable acidity, there is another acidity pool called potential acidity and it is the maximum amount of acidity which a partly or totally reduced soil may contain after it has been completely oxidized. Generally you can see this potential acid in case of acid sulphate soils. And, so, have covered the four pools of acidity. Remember that, whenever we go for ameliorating the soil acidity by adding the liming material we neutralize only the active acidity. So, this is very important. Primarily we are we are utilising the active acidity.

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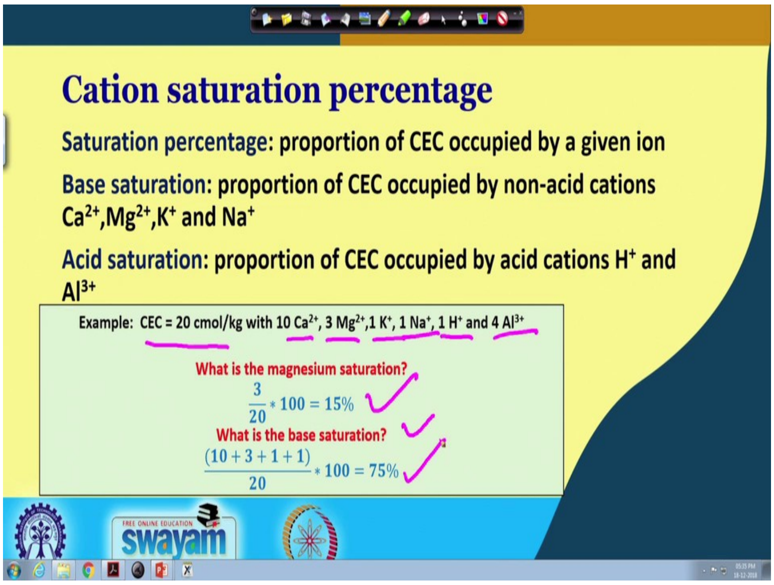

Cation saturation percentage

Saturation percentage: proportion of CEC occupied by a given ion

Base saturation: proportion of CEC occupied by non-acid cations Ca^{2+},Mg^{2+},K^+ and Na^+

Acid saturation: proportion of CEC occupied by acid cations H^+ and Al^{3+}

Example: CEC = 20 cmol/kg with 10 Ca^{2+}, 3 Mg^{2+},1 K^+, 1 Na^+, 1 H^+ and 4 Al^{3+}

What is the magnesium saturation? ✓

$$\frac{3}{20} * 100 = 15\% \checkmark$$

What is the base saturation? ✓

$$\frac{(10+3+1+1)}{20} * 100 = 75\% \checkmark$$

Now, cation saturation percentage you know the proportion of the CEC which is occupied by given ion and we already covered what is percent base saturation or proportion of the CEC occupied by non-acidic cations like calcium, magnesium, potassium and sodium.

And, acid saturation is basically proportion with this CEC which is occupied by acid cations like H plus and Al_3 plus. So, you can see here if the CEC is 20 centimol per kg with ten calcium you know with this 10 unit of calcium 3 magnesium, 1 potassium, 1 sodium, 1 H plus and 4 Al_3 plus, what is the magnesium saturation? Obviously, will get 3 by 20 that is 15 percent; what is the base saturation? That is 75 percent. So, obviously, you know this these are important aspects for calculating the acid saturation, as well as base saturation of a soil ah.

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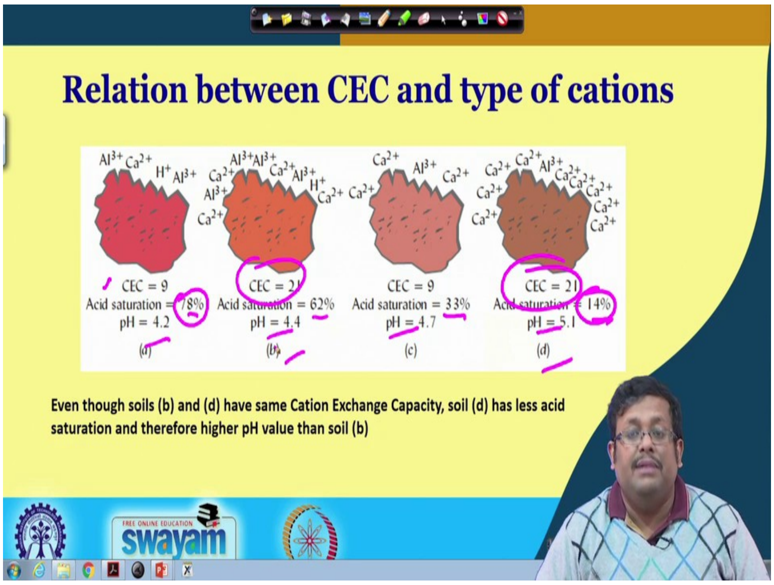

Relation between CEC and type of cations

Even though soils (b) and (d) have same Cation Exchange Capacity, soil (d) has less acid saturation and therefore higher pH value than soil (b)

So, what is the relation between CEC and types of cations? You can see that although there are four different types of soil here hypothetical soil. So, here in case of soil you can see although the acid saturation is changing from soil a that is 78 percent to 62 percent the 33 percent to 14 percent. They have implication only on the pH. So, acid saturation is it you know inter linked with the pH. So, as the acid saturation is increasing from 14 percent to 78 percent the pH is getting decreased.

However, that may not be reflected in the total CEC because you can see here soil b and soil d are having the same CEC, that is CEC to 21. However, soil b is less acidic than the soil d. So, basically here you can we can see that acid saturation has an implication on the soil respective soil pH.

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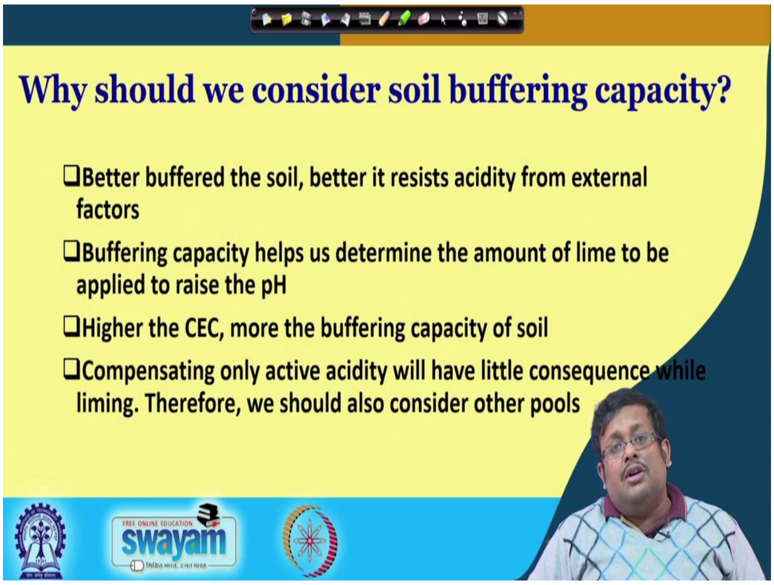

Why should we consider soil buffering capacity?

- ❑Better buffered the soil, better it resists acidity from external factors
- ❑Buffering capacity helps us determine the amount of lime to be applied to raise the pH
- ❑Higher the CEC, more the buffering capacity of soil
- ❑Compensating only active acidity will have little consequence while liming. Therefore, we should also consider other pools

So, so, why should we consider soil buffering capacity? Now, better buffer the soil better it resist the acidity from external factors. Remember that you know a better buffer for soil is always good for you know for resisting any abrupt change of you know soil pH when we add different types of external factors. And, buffering capacity helps to us to determine the amount of lime to be applied to raise the pH and higher the CEC more the buffering capacity of the soil. Obviously, they have more reason then and compensating only active acidity will have little consequence while liming. Therefore, we should also consider the other pools also.

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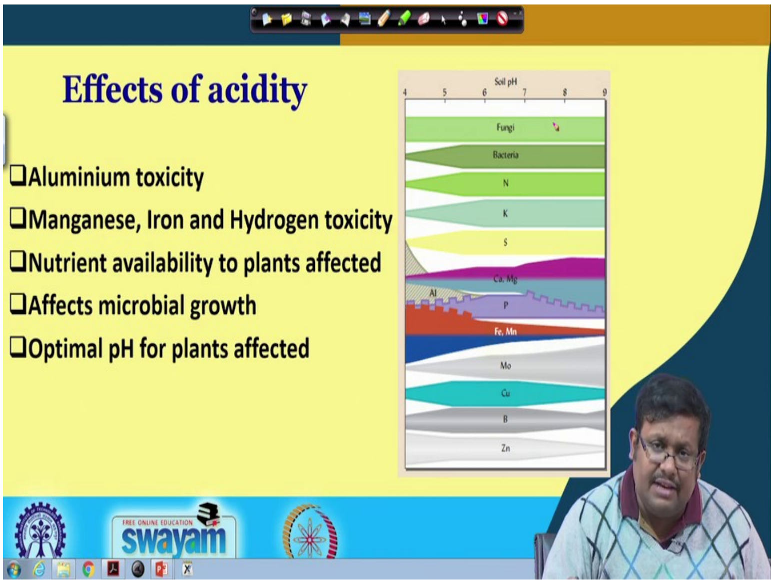

Effects of acidity

- ❑Aluminium toxicity
- ❑Manganese, Iron and Hydrogen toxicity
- ❑Nutrient availability to plants affected
- ❑Affects microbial growth
- ❑Optimal pH for plants affected

So, effects of let us see the what are the effects of the acidity. Obviously, as I have told you at the beginning of this lecture different types of microorganisms are present at different levels of soil acidity. Obviously, fungi are more or less than you know present as you can see in the acidic soil. However, bacteria is present only at near neutral condition that is from 6 to 7. However, when there is a very low pH the bacteria cannot thrive and most of the nutrients are the thickness of these bars are basically representing the availability.

So, you can see N, K, S all these are more available around the along the pH of new near neutral pH that is from 6.5 to 7.5 and at the pH acid pH condition which is less than 5.5, all these are not available on the availability decreases. So, most of the. So, in most of the cases you will see that, you know the availability of the mineral nutrients are decreased.

However, you can see here and opposite train for aluminium, so, aluminium toxity increases in case of acid soil. Aluminium toxity is very very harmful for the growth and germination of the crop and manganese iron and hydrogen toxity also you know also occurs and nutrient availability to plants affected due to the acidity it can also affects the microbial growth and you know optimal pH for plants are basically also affected. So, maintaining an optimum pH is very very important for you know for an optimum soil acidity.

So, guys let us wrap up here and in the next lecture, we will try to finish this soil acidity and then will then will start the soil alkalinity, sodisity and other topics. So, I hope that you have you know gained some knowledge about this soil acidity and how soil acidity occurs due from the different factors and what are the different pools of soil acidity. So, will we will stop here and from the next lecture will see how we can ameliorate soil acidity and using different types of liming materials and what are the other important factors for considering the amelioration of the soil acidity. And so, till then you know you have a good day and well meet in the next lecture to discuss these things in details.

Thank you.