

Soil Fertility and Fertilizers
Professor Somsubhra Chakraborty
Department of Agricultural and Food Engineering
Indian Institute of Technology, Kharagpur
Lecture: 29
Soil Testing and Soil Fertility Evaluation Methods (Contd.)

(Refer Slide Time: 00:29)



Welcome friends to this sixth week of lectures of NPTEL online certification course of Soil Fertility and Fertilizers. In this week, we are discussing about soil testing and soil fertility evaluation methods. And now, we are going to discuss lecture number 29. And in our previous lectures we have discussed about the basis for soil testing and plant testing why we require them and what are the basic concepts behind soil fertility on our plant nutrition status identification.

We have also discussed the plant based fertility evaluation and also we have discussed about the soil sample process, soil basics of soil testing, what should be the optimum depth of collection? What are the different types of soil, sampling procedure or what are the different types of soil sampling designs or what type of sample collection methods we have discussed simple random sampling, then stratified random sampling, zone sampling, grid sampling, hybrid sampling, zigzag sampling, what are the different types of tools which we use for soil sample collection, we have discussed.

We have also discussed what is the procedure of soil sample collection then we have discussed what is furrow slice how to collect the V shape the sample from the V shaped cut

and then how to develop a composite sample, what are the criteria for develop for collecting the composite sample we have discussed.

So, now, we are going to discuss some of the way, you know important routine soil tests for determination of the soil pH, electrical conductivity and soil organic matter and available macronutrients in this lecture.

(Refer Slide Time: 02:29)

CONCEPTS COVERED

- Determination of soil pH
- Determination of soil electrical conductivity
- Determination of soil organic matter
- Determination of available N
- Determination of available P
- Determination of available K

So, these are the concepts which we are going to cover first of all Determination of soil pH, then Determination of soil electrical conductivity and then Determination of soil organic matter, then Determination of available nitrogen, available phosphorus and available potassium. So, these are the very basic and most routine soil tests which we will get in most of the soil testing laboratories.

So, apart from that we also test micronutrients and also lime requirement and so, other things, but for identification for estimation of the micronutrients, we required high valued instruments like atomic absorption spectrophotometer or ICP, which we will be discussing in our last lecture of this week. However, in this lecture, we are going to discuss why soil pH and how we measure the soil pH, how we measure the soil electrical conductivity, what are the process of determination of soil organic matter, determination of available nitrogen, available phosphorus and available potassium.

(Refer Slide Time: 03:38)

KEYWORDS

- Soil organic matter
- Available N
- Available P
- Available K
- Soil pH

So, these are the keywords of this lecture, soil organic matter, then available nitrogen, available phosphorus, available potassium and soil pH.

(Refer Slide Time: 03:50)

Determination of soil pH

- ❖ Determination of pH measures **hydrogen ions activity** in the soil-water system.
- ❖ It is defined as a **negative logarithm** of the hydrogen ion activity.
- ❖ The nutrient availability is **maximum** at neutral pH and decreases with increased acidity or alkalinity.

Principle

- ❖ The pH is measured by a pH meter, in which the potential of the hydrogen ion indicating electrode is measured potentiometrically against the **calomel saturated reference electrode**.
- ❖ Before measuring the pH of the soil, the instrument has to be **calibrated** with a **standard buffer solution** of known pH.
- ❖ pH is also affected by the temperature. Hence, the pH meter should be adjusted to the temperature

So, remember that soil pH is basically a negative logarithm of hydrogen and concentration. So, determination of pH basically measures the hydrogen and activity in the soil water system and these pH influences so many other soil fertility parameters that is why we first measured the soil pH in any soil testing lab. So, the nutrient availability for example, the nutrient availability is maximum at neutral pH and decreases with increased acidity or alkalinity.

So, unless we know the soil pH we do not understand what is the reason behind that nutritive available nutrient you know nutrient content at a particular situation also to determine what type of extractant we will be using for determination of soil parameters. We require the soil pH for example in case of phosphorus unless we do not know whether the soil is alkaline or acidic in nature, we will not be able to identify which method we should follow.

So, that is why soil pH is a very important parameter we should measure and the principle of soil pH measurements says that the pH is measured by a pH meter in which the potential of the hydrogen ion indicating electrode is measured potentiometrically against the calomel saturating reference electrodes. So, there are two electrodes, one is the, one is a thin glass membrane electrode which goes in direct contact with the soil solution, soil and water solution and inside the probe there is a reference electrode.

So, the potential difference that develops when we dip the probe in the soil water solution that creates the, that is basically the generating force of the soil pH measurement. So, before measuring the pH of the soil the instrument has to be calibrated with a standard buffer solution of known pH and pH is also affected by temperature remember that, so, the pH meters should be adjusted to the local or the room environment temperature also. So, what we do basically we make a soil water suspension and then we dip the probe of soil pH meter to measure the soil pH of that you know how to measure the soil pH.

(Refer Slide Time: 06:59)

Soil pH - what is it?

- measure of the acidity or alkalinity of a soil
- concentration of hydrogen ions (H^+) in the soil solution

Increasing acidity ← NEUTRAL → Increasing alkalinity

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

↑ Battery acid ↑ Beer ↑ pH Water 1:5 ↑ Soap sol'n ↑ Caustic soda

↑ Ideal pH for plant growth

Digital pH meter

https://www.ccsnknowledgebase.vic.gov.au/brown_book/20_pH.htm

IIT Bombay NPTEL

So, this is a digital pH meter and as you can see, this is the soil probe, I am just indicating here in the screen. So, this is the pH probe and this is the pH meter. And as you can see, there

are different types of this is the pH scale. So, based on this pH scale, you can say whether the soil is acidic or alkaline. So, neutral pH generally you know ranges from 6.5 to 7.5 the neutral proper neutral pH is 7 and of course, as you go beyond 7 that increases the alkalinity and go below 7 that increases the acidity.

(Refer Slide Time: 07:44)

Procedure

- ✓ Soil to water ratio of 1:2 (pH)
- ✓ Take 20 g soil in a 100 ml beaker and add 40 ml of distilled water.
- ✓ The suspension is stirred at a regular interval for 30 minutes.
- ✓ Determine the pH by immersing electrodes in suspension.
- ✓ For soils containing high salts, the pH should be determined using a 0.01M calcium chloride solution.

Interpretation

▪ < 5.0	:	Strongly Acidic
▪ 5.1 – 6.5	:	Slightly Acidic
▪ 6.6 – 7.5	:	Neutral
▪ 7.6 – 8.0	:	Mild alkaline
▪ > 8.0	:	Strongly Alkaline

So, what is the procedure of soil pH determination. So, we first create a suspension of soil to water like 1 is to 2 volume you know suspension and so, we and then for example, we can take you know 20 gram of soil in a 100 ml beaker and 40, and we add 40 ml of distilled water and the suspension is stirred at regular interval for 30 minutes and why we stirred that, we stir that to ensure that all the hydrogen ions comes from the soil surface to the soil water, so that we can measure their activity in the suspension.

So, once we do this stirring intermittently for 30 minutes, then we measure the pH by immersing the electrode in the suspension electrode or probe. So, for soils containing the high salts, the pH should be determined using 0.01 Molar calcium chloride solution. Now once we have measured the soil pH, how to interpret.

So, if the soil pH is less than 5 we call it strongly acidic soil, if it is 5.1 to 6.5, we call it slightly acidic soil, if it is from 6.6 to 7.5, we call it a neutral soil. If it is from 7.6 to 8, we call it mildly alkaline soil and if it is more than 8 we call it strongly alkaline soil. So, depending on the soil pH, you can interpret you know you can interpret whether it is suitable for any specific crop or not based on the availability of the nutrients.


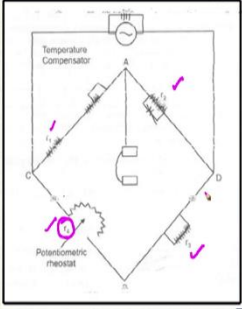
(Refer Slide Time: 09:33)

Determination of soil electrical conductivity

- ❖ Amount of soluble salts in a sample is expressed in terms of the electrical conductivity (EC) and measured by a conductivity meter.

Principle

- ❖ A simple Wheatstone bridge circuit is used to measure EC.
- ❖ The bridge consists of two known and fixed resistance, r_1 , and r_2 , one variable- standard resistance r_4 and the unknown r_3 .
- ❖ The variable resistance r_4 is adjusted until a minimum or zero current flows through the AC galvanometer.



So, the second most important parameter we generally measure is the electrical conductivity. Now, these amounts of salts, soluble salts in a sample is generally expressed in terms of electrical conductivity and generally measured by a conductivity meter. So the principle of the conductivity meter is based on the Wheatstone bridge principle. So we already know what is Wheatstone bridge principle or Wheatstone bridge circuit So, this is a Wheatstone bridge circuit and as you can see here, the bridge consists of two known and fixed resistance.

So, these are r_1 and r_2 and one variable resistance which is r_4 and an unknown resistance that is r_3 . So, the variable resistance r_4 can be adjusted until a minimum or 0 current flows through the AC galvanometer and this is based on this principle, we generally measure the soil electrical conductivity.

Now, why electrical conductivity gives the measurement of soil salts? Because, you know salts are made up of cations and anions and these cations and anions are the major conductor of electricity in the soil. So, in any you know, in the soil system, so, if we measure the conductivity of a soil or electrical conductivity of the soil that will indirectly interpret the soil concentration.

Of course, if this if a soil has more amount of soils that will have higher electrical conductivity because they will have more ions to conduct the electric you know to conduct the elect, the electricity so, as a result of that, you know we generally measure the electrical conductivity for determining the soluble salts in the soil.

(Refer Slide Time: 11:35)

Procedure

- ✓ Take 20 g of soil in a 100 ml beaker, add 40 ml of distilled water and shake intermittently for 30 minutes.
- ✓ Determine the conductivity of the supernatant liquid with the help of a conductivity meter.
- ✓ The electrical conductivity of saturation extract is also determined for salinity ratings.

Interpretation

EC (dS/m)

- > 4.0 Saline soil
- < 4.0 Non-saline soil

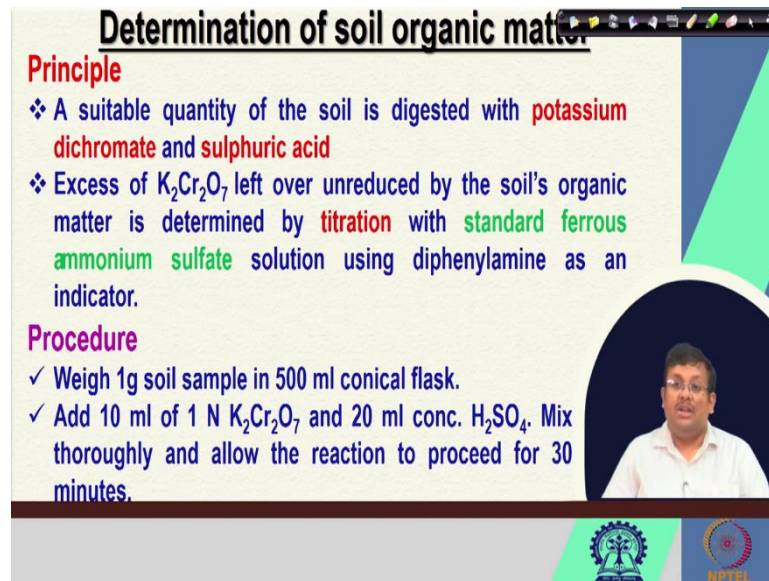
Now, what is the procedure? So, generally we take 20 grams of dried and processed soil or dried ground soils in 100 ml beaker and then we add 40 ml of distilled water and shake intermittently just like pH for 30 minutes and then we can determine the conductivity of the supernatant liquid with the help of a conductivity meter and the electrical conductivity of a saturation extract is also determined for salinity ratings.

So, remember there are different from methods of measurement of soil pH and soil electrical conductivity sometimes, we create a saturated paste by mixing the water directly into the soil and making a paste and keep it one night for equilibration and then we in the next day we directly dip the electrode in the soil to measure the soil pH and electrical conductivity.

Sometime we do 1 is to 2 soil water suspension and then we measure the soil pH and electrical conductivity. Sometime we do the saturation extract that means we saturate the soil with distilled water and then we extract the set you know from those from that saturated soil and then we measure the electrical conductivity of that saturation extract.

So, this is another method of measurement of soil electrical conductivity. So, there are different methods. So, how to interpret the soil salinity. So, if the electrical conductivity is measured and then generally the unit of the electrical conductivity is decisiveness per meter. So, if it is more than 4 decisiveness per meter, 4 decisiveness per meter, the electrical conductivity then we call it a saline soil if it is less than 4 then we call it a non-saline soil. So, this is the general threshold value for differentiating a saline soil from a non-saline soil.

(Refer Slide Time: 13:35)



Determination of soil organic matter

Principle

- ❖ A suitable quantity of the soil is digested with potassium dichromate and sulphuric acid
- ❖ Excess of $K_2Cr_2O_7$ left over unreduced by the soil's organic matter is determined by titration with standard ferrous ammonium sulfate solution using diphenylamine as an indicator.

Procedure

- ✓ Weigh 1g soil sample in 500 ml conical flask.
- ✓ Add 10 ml of 1 N $K_2Cr_2O_7$ and 20 ml conc. H_2SO_4 . Mix thoroughly and allow the reaction to proceed for 30 minutes.

The slide includes a video inset of a presenter in the bottom right corner and logos for IIT Bombay and NPTEL at the bottom.

The third important property we generally measured in a routine soil test is the organic matter or soil organic matter. Now, the principle says that a suitable quantity of the soil is digested with potassium dichromate and sulfuric acid. So, here generally we take the soil sample and then we mix it with the potassium dichromate and sulfuric acid.

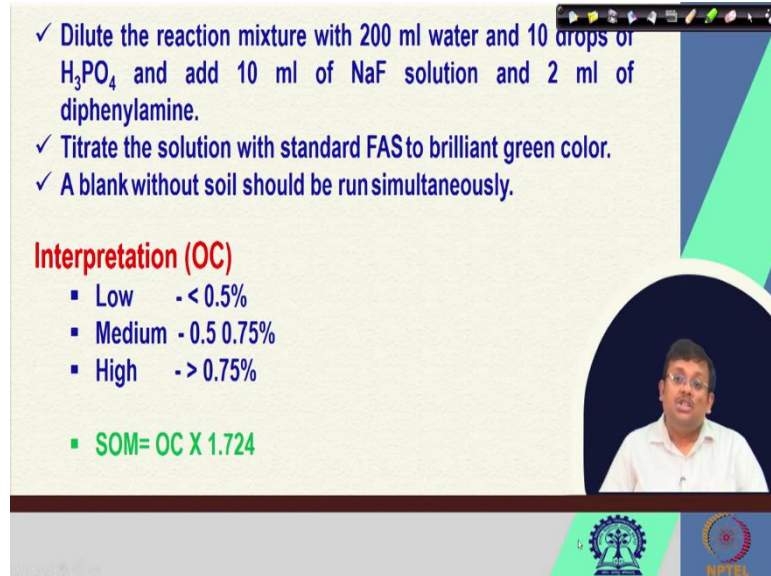
Now, this potassium dichromate generally oxidize whatever carbon is there in the soil. And then the excess amount of $K_2Cr_2O_7$ or potassium dichromate which is leftover unreduced by the soil organic matter is determined by titration with standard ferrous ammonium sulfate solution using diphenylamine as an indicator. Remember that here whatever carbon is there in the soil in the presence of $K_2Cr_2O_7$ or potassium dichromate and sulfuric acid it oxidized into carbon dioxide and $K_2Cr_2O_7$ generally reduced.

So when all the carbon which is present in the soil is oxidized and some amount of $K_2Cr_2O_7$ is generally left on reduced. So we measured that unreduced $K_2Cr_2O_7$ by standard by titrating against the standard ferrous ammonium sulfate solution using the diphenylamine indicator and then from there we can identify, this is the amount of $K_2Cr_2O_7$ which has been already consumed by for oxidation of carbon to carbon dioxide. So, this is the organic carbon present in the soil.

So, for this generally we take excess amount of $K_2Cr_2O_7$, so, that there must be some amount left or unreduced after the conversion of carbon to carbon dioxide. So, what is the process? The process is first of all we take 1 gram of soil samples in a 500 ml of conical flask then we add 10 ml of 1 normal potassium dichromate and 20 ml of concentrated H_2SO_4 and mix

thoroughly the mixture and then allow the reaction to proceed for 30 minutes, so, we keep it for 30 minutes.

(Refer Slide Time: 16:01)



✓ Dilute the reaction mixture with 200 ml water and 10 drops of H_3PO_4 and add 10 ml of NaF solution and 2 ml of diphenylamine.

✓ Titrate the solution with standard FAS to brilliant green color.

✓ A blank without soil should be run simultaneously.

Interpretation (OC)

- Low - < 0.5%
- Medium - 0.5 - 0.75%
- High - > 0.75%

▪ $SOM = OC \times 1.724$

And then we dilute the reaction mixture with 200 ml of water 10 drops of phosphoric acid and 10 ml of sodium fluoride solution and 2 ml of diphenylamine and then we titrate the solution with standard ferrous ammonium sulfate to bright to get the brilliant green color.

So, a blank without soil should be also run simultaneously for calculation of the organic carbon, I have not shown here the calculation of the organic carbon you can see it in the standardized book. Now, once we get the organic carbon remember that the method will give us the organic carbon this this method is also known as Walkley and Black method.

So, because we and it is named by the same from, the again you know, names, Walkley and Black suggest the, this process was first published by these two scientists to Walkley and Black in the year 1934 and it was published in a journal called soil science.

So, once in this Walkley and Black method the extract the extraction of organic carbon is around 77 percent. So, whatever we get the result from the calculation we have to multiply with 1.33 to get the actual organic carbon. So, once we get the actual organic carbon considering the 77 percent recovery, then we can interpret based on the scale.

So, if it is less than 0.5 then we call it a low organic carbon, if it has organic carbon content, you know from 0.5 to 0.75 percent, we call it medium or concentration of organic carbon and

if it is having high concentration, it should have more than 0.75 percent of organic carbon. Now, how to convert these organic carbons to organic matter soil organic matter.

So, to convert this organic carbon to soil organic matter, we have to multiply it with the 1.724 which is also known as Van Bemmelen factor. So, this Van Bemmelen factor is generally calculated or you know, we derived this Van Bemmelen factor as 1.724 because we assume that in organic matter content around 58 percent of organic carbon.

So, if we consider that organic matter consists of 58 percent of carbon, then to convert the organic carbon to organic matter, we have to multiply it with this Van Bammelen factor or 1.724. So, this is how we get the soil organic matter.

(Refer Slide Time: 19:00)

Determination of plant available Nitrogen

❖ Estimated by the micro- Kjeldahl method

Principle

- In soil, Nitrogen (N) present in organic and inorganic forms. However, maximum amount of it remains in organic form, which cannot be used by plants. Amount of plant available N in soil depends upon N mineralization, which again depends on C: N ratio. Plants can uptake only NH_4^+ and NO_3^- forms of N, though they together hardly occupy 1% of total N in normal soils. It is therefore, necessary to estimate the different forms of mineralized or available N. The alkaline potassium permanganate (KMnO_4) method (by Subbiah and Asija, 1956) is the standard one for it.
- A known weight of soil is treated with an excess of alkaline KMnO_4 , which extracts easily oxidizable fraction of organic matter. Ammonia evolved is absorbed in a known volume of standard acid, the excess of which is titrated against standard alkali using methyl red as an indicator

The slide also features a small inset video of a man speaking and logos for IIT Bombay and NPTEL at the bottom.

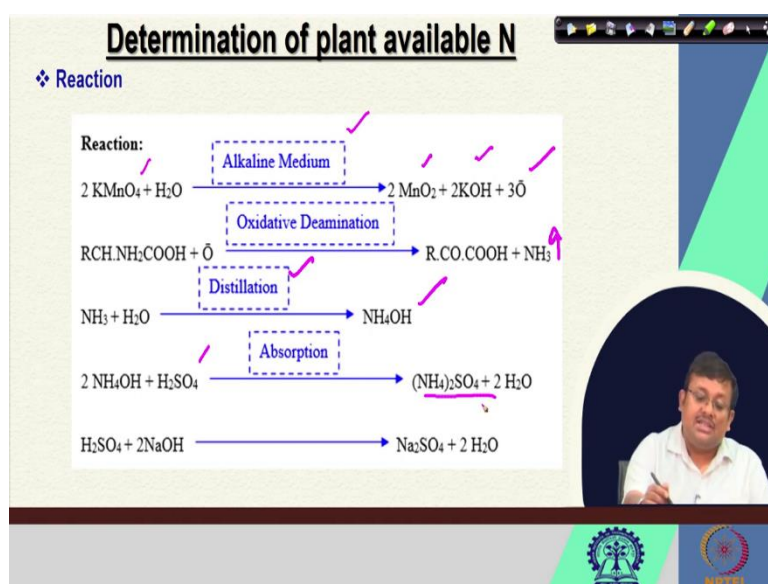
The next important parameter which we measure in the laboratory is the available nitrogen or plant available soil nitrogen and this is estimated by the micro gentle method. Now remember in the soil nitrogen present in basically organic and inorganic form however, maximum amount of nitrogen remain in organic form, which cannot be used by the plants. Now amount of plant available nitrogen in soil depends upon nitrogen mineralization, which again depends on carbon to nitrogen ratio or CN ratio.

Plant can uptake only ammonium and nitrate from the now from of nitrogen we know that. So, though they, you know, together hardly occupy 1 percent of the total nitrogen in normal soil. So, it is therefore necessary to estimate the different forms of mineralized are available nitrogen and so, this alkaline potassium permanganate method, it was given by the Subbiah

and Asija in 1956 and we generally use this method for determination of soil available nitrogen.

So, what we do what is a principle behind this idea, for estimation of available nitrogen. So, here a known weight of soil is treated with an excess of alkaline KMnO_4 or potassium permanganate which extract easily oxidizable fraction of organic matter and ammonia evolved is absorbed and as a result there is evolution of ammonia. So, the ammonia evolved is absorbed in a known volume of standard acid the excess of which is titrated against standard alkali using methyl red as an indicator.

(Refer Slide Time: 20:53)



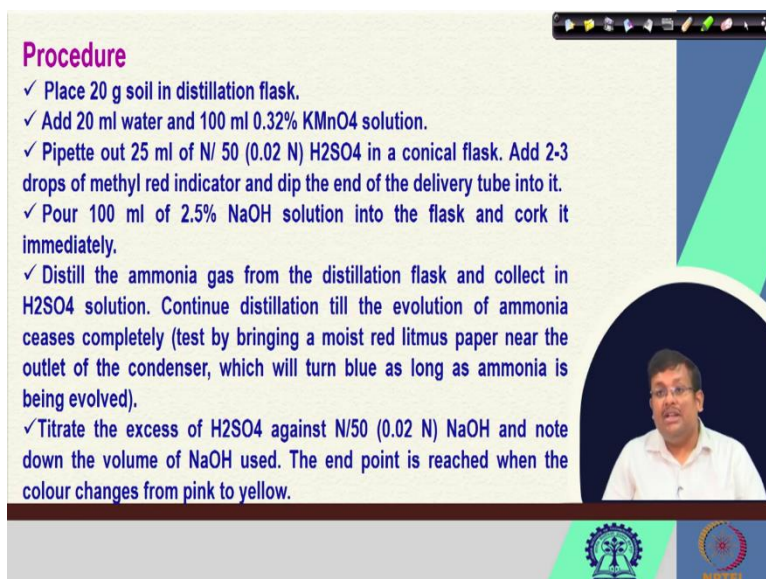
Now, remember guys there are different versions or different variation of this method. However, in principle, this is the crux of the Subbiah and Asija based method, you will see that people are also using different types of other reagents for absorption of ammonia and titration but, that is also fine.

So, these are the basic reaction you can see here in the first reaction, potassium permanganate in the alkaline medium, it produced this manganese oxide and then potassium hydroxide and this nascent oxygen and this nascent oxygen basically reacts with amino acids to create the oxidative deamination and creating the ammonia, evolving the ammonia gas.

So, these ammonia reacts with water to produce this ammonium hydroxide in the distillation process and then these ammonium hydroxides can be absorbed in H_2SO_4 or sulfuric acid to produce the ammonium sulfate and the excess amount of H_2SO_4 , can be you know titrated

against sodium hydroxide to measure this plant available nitrogen. So, this is how this process basically operates.

(Refer Slide Time: 22:17)



Procedure

- ✓ Place 20 g soil in distillation flask.
- ✓ Add 20 ml water and 100 ml 0.32% KMnO_4 solution.
- ✓ Pipette out 25 ml of N/50 (0.02 N) H_2SO_4 in a conical flask. Add 2-3 drops of methyl red indicator and dip the end of the delivery tube into it.
- ✓ Pour 100 ml of 2.5% NaOH solution into the flask and cork it immediately.
- ✓ Distill the ammonia gas from the distillation flask and collect in H_2SO_4 solution. Continue distillation till the evolution of ammonia ceases completely (test by bringing a moist red litmus paper near the outlet of the condenser, which will turn blue as long as ammonia is being evolved).
- ✓ Titrate the excess of H_2SO_4 against N/50 (0.02 N) NaOH and note down the volume of NaOH used. The end point is reached when the colour changes from pink to yellow.

So, the procedure says that first you take 20 gram of soil in a distillation flask, then you add 20 ml of water and 100 ML of 0.32 percent of potassium permanganate solution and then you pipette out 25 ml of N by 50 or 0.02 normal of sulfuric acid in a conical flask, you should add 2 to 3 drops of methyl red indicator and dip the end of the delivery tube into it and you have to pour 100 ml of 2.5 percent solution into the flask and cork it immediately.

And distill the ammonia glass from the distillation flask and collect it in the H_2SO_4 solution. Continue distillate till the evolution of the ammonia seizes completely and you can test it by bringing a moist red litmus paper near the outlet of the condenser which will turn blue as long as the ammonia is being evolved. And when it stopped turning into blue, then you can understand okay no further ammonia is evolving. So, you can stop the distillation process .

Then you should titrate the excess amount of H_2SO_4 which you have taken against this 0.02 normal of sodium hydroxide and note down the volume of sodium hydroxide used. The end point is reached when the color changes from pink to yellow. So, this is how you measure the soil available nitrogen.

(Refer Slide Time: 23:41)

Calculations

Weight of soil taken:	20 g
Volume of N/50 H ₂ SO ₄ taken:	25 ml
Volume of N/50 NaOH used (titrate value):	X ml
Volume of N/50 acid used for NH ₃ absorption:	(25 - X) ml
Now, 1 ml of N/50 H ₂ SO ₄ = 0.02 meq. Of N = 0.28 mg N = 0.00028 g N	
Therefore, % of available N =	$(25 - X) \times 0.00028 \times 100/20 = Y$
Available N in soil (ppm) =	$Y \times 100000 = Z$
Available N in soil (kg/ha) =	$Z \times 2.24$

Interpretation of test result

- < 272 Low {Amount of N (kg/ha)}
- 272-544 Medium
- >544 High

This is the calculation. So, if you have taken 20 grams of soil and volume of sulfuric acid taken 25 ml, volume of 0.02 normal sodium hydroxide taken is X ml and volume of so the volume of N by 50 acid use for ammonia absorption is 25 minus X ml. So, now 1 ml of n by 50 H₂SO₄ is 0.02 equivalent of nitrogen which is 0.00028 gram of nitrogen and so therefore, we can calculate the percent of available nitrogen. So, this is the percentage of available nitrogen in ppm.

So, this is the percentage of available nitrogen once you get the percentage of available nitrogen you have to multiply it with the 10,000 because you know 1 percent equals to 10,000 ppm. So, you will get the values Z that is in ppm. Now, if you have to convert this ppm value to kg per hectare value, you have to multiply it with the 2.24 factor. So you will get the nitrogen, available nitrogen in kg per hectare.



So how to interpret the results. So in general, in Indian condition, if the available nitrogen is less than 272 kg per hectare, then we call it a low amount of nitrogen. When it is 272 to 544 kg per hectare, then we call it a medium amount of nitrogen available nitrogen. If it is more than 544 kg of nitrogen then we call it a high nitrogen content. So this is how we interpret the result.

(Refer Slide Time: 25:18)

Determination of available P in soil

Principle

- ❑ Phosphorus is estimated by the Olsen's method (1954) (Neutral –Alkaline pH)
- ❑ Phosphorus is extracted from the soil with 0.5 M NaHCO_3 at a nearly constant pH of 8.5.
- ❑ The phosphate ion in the solution treated with ascorbic acid in an acidic medium provides a blue color complex.





Now, the next important parameter is the soil available phosphorus. Now, there are two methods however here I will, you know, I will mention I will discuss only one method. So, one method which is generally used for neutral to alkaline pH of the soil that is called Olson's method and this method generally use 0.5 Molar of sodium bicarbonate at a nearly constant pH of 8.5. So, what happens so, the phosphate ion in the solution treated with basically ascorbic acid in an acidic medium, which provides a blue color complex.

(Refer Slide Time: 25:57)

Reagents

1. **0.5 M Sodium bicarbonate (NaHCO_3) solution:** Dissolve 42 g of NaHCO_3 in distilled water to get one litre solution and adjust the pH of the solution to 8.5 by small quantity of NaOH.
2. **Activated Charcoal:** Darco G-60 (P-Free)
3. **5 N Sulphuric acid (H_2SO_4)**
Solution: Add 141 ml of con. H_2SO_4 to 800 ml of distilled water. Cool the solution and dilute to one litre with distilled water.
4. **Reagent A:**
 - Dissolve 12.00 g of ammonium paramolybdate in 250 ml of distilled water.
 - Dissolve 0.2908 g of potassium antimony tartrate ($\text{KSbO}_4 \cdot \text{H}_2\text{O}$) in 100 ml distilled water.
5. **Ascorbic acid working solution (Reagent B):** Dissolve 1.056 g of ascorbic acid in 200 ml of reagent A and mix. This ascorbic acid (reagent B) should be prepared as required because it does not keep more than 24 hours.
6. **Standard phosphate solution:** Weigh 0.4393 g of potassium dihydrogen phosphate (KH_2PO_4) into one litre volumetric flask. Add 500 ml of distilled water and shake the contents until the salt dissolves. Dilute the solution to one litre with distilled water to get 100 ppm P solution. Dilute 20 ml of 100 ppm P solution to one litre to get form-working solution of 2 ppm.



So, in the Olsen method, so, here you can see there, the different types of reagents we use, we use either 0.5 Molar of sodium bicarbonate solution, we use also activated charcoal to remove

any color interference, we also use 0.5 normal of sulfuric acid solution and then we can create a reagent A. So, reagent A is basically dissolving 12 gram of ammonium paramolybdate in 250 ml of distilled water and then we dissolve 0.2908 gram of potassium antimony tartrate in 100 ml of distilled water.

So, both solution mix thoroughly and made 1 liter in volumetric flask with the help of distilled water and these dissolve reagents to 1 liter of 0 or 5 normal sort of sulfuric acid. So, this is reagent A and ascorbic acid working solution is also known as reagent B. So, you dissolve 1.056 gram of ascorbic acid in 200 ml of reagent A, this ascorbic acid also known as reagent B should be prepared as required because it does not keep more than 24 hours.

So, you cannot keep it for more than 24 hours. And apart from that you have to create the standard phosphate solution by dissolving the potassium dihydrogen in phosphate in a double distilled water for development of the standard curve. Remember for (())(27:32) measurement, you are required to develop a standard curve.

(Refer Slide Time: 27:38)

Preparation of standard curve

- Take different concentration of P (0, 1, 2, 3, 4, 5, etc ml of 2 ppm standard P Solution) in 25 ml volumetric flasks.
- Add 5 ml of the 0.5M NaHCO_3 extracting solution to each flask, and acidify with 5N H_2SO_4 drop by drop.
- Add about 10 ml distilled water and 4 ml of reagent 'B', then shake the solution.
- Make the volume 25 ml by distilled water.
- The intensity of blue colour is read on spectrophotometer at 660 nm wavelengths after 10 minutes.
- Plot the curve by taking P concentration on X axis and colorimeter reading on Y axis. Repeat the process till you get straight line relationship.
- Calculate the factor i.e. 1 colorimeter reading is equal to how much ppm of phosphorus?

The slide also features a video inset of the presenter and logos for IIT Bombay and NPTEL at the bottom.

So, how to prepare the standard curve. So, you take different concentration of phosphates solution and in 25 ml volumetric flask. So, first you create a 2 ppm working solution standard phosphorous solution and from there you take 0, 1, 2, 3, 4, 5 ml and in a 25 ml of volumetric flask and then you add 5 ml of 0.5 Molar of sodium bicarbonate extracting solution rolls and extractant to each of these flask and acidify with 5 normal sulfuric acid drop by drop and then add about 10 ml of distilled water and 4 ml of reagent B then shake the solution, make the

volume of 25 ml by distilled water and the intensity of the, there will be a blue color development.

So the intensity of the blue color is read on spectrophotometer at 660 nanometer wavelength after 10 minutes and plot the curve by taking phosphorus concentration on x axis and colorimetric reading on y axis, repeat the process till you get the straight line relationship and then calculate the factor that is you know colorimeter reading is equal to how much ppm of phosphorus and from there you can calculate from the unknown sample.

(Refer Slide Time: 28:53)

Procedure

Procedure :

- Take 2.5 g of soil sample in 150 ml conical flask and 0.5 g Darco G-60 activated charcoal.
- Then add 50 ml of 0.5 M NaHCO₃ solution and shake the solution for 30 minute in a shaker. Similar process run for a blank without soil.
- Filter the suspension through the Whatman no. 40 paper.
- Take 5 ml aliquot of the extract in a 25 ml volumetric flask, and acidify with 2N H₂SO₄.
- Add small quantity of distilled water, and then add 4 ml of reagent B.
- The intensity of blue colour is read on spectrophotometer at 660 nm wavelength after 10 minutes.

Observations :

1. Weight of soil sample : 2.5 g
2. Volume of extractant used : 50 ml
3. Volume of filtrate used : 5 ml
4. Absorbance : R
5. Absorbance from standard curve : A
6. Concentration of P for absorbance A : P ppm

Calculation :

$$\text{Available P (kg ha}^{-1}\text{)} = \frac{R \times F \times 50 \times 2.24}{5 \times 2.5}$$

Where, T (factor) = D / A

Limits of available P in soil :

Very low	: Less than 5 P kg ha ⁻¹
Low	: 5-10 P kg ha ⁻¹
Medium	: 10-20 P kg ha ⁻¹
High	: 20-40 P kg ha ⁻¹
Very high	: More than 40 P kg ha ⁻¹

So, the procedure if you have a soil sample, how to do the phosphorus estimation. So, this is a colorimeter which you can use to measure the soil phosphate concentration. So, first of all, you have to take 2.5 grams of soil sample in 150 ml of conical flask and you add 0.5 gram of this activated charcoal then you add this 50 ml of this Olson reagents and then shake for 30 minutes and in a shaker and similar process run for a blank without the soil and then you filter the suspension through the Whatman 40 paper and then take 5 ml of a liquid of the extract every 25 ml of volumetric flask and acidify with 5 normal H₂SO₄ and you know add small quantity of distilled water and then add 4 ml of reagent B and the intense there will be blue color development. Due to this ascorbic acid and you have to read the color at 660 nanometer wavelength after 10 minutes.

So you have to keep it for 10 minutes for color development and then you measure the intensity. So these are the measurement and calculations, so, weight of the sample here 2.5 grams, volume of the extractant 50 ml, volume of filtrate 5 ml, absorbance R absorbance

from the standard curve A and concentration of phosphorus for absorbance A equal to B ppm. So, this is how you calculate available phosphorus and these are the interpretations.

So, if it is less than 5 kg of phosphorus per hectare, then it is very low, 5 to 10 kg then it is low, from 10 to 20 kg phosphorus it is medium, 20 to 40 kg it is high and very high is more than 40 kg. So, this is how you calculate the phosphorus and estimate the phosphorus available phosphorus. Now, to convert this phosphorus to available P₂O₅ we had to multiply with a factor 2.29.

So, this is an important factor that you know to convert this phosphorus to for P₂O₅, because this P₂O₅ calculation is required because most of the fertilizer elements are calculated based on this P₂O₅ content. So, generally we also estimate or interpret the values in terms of P₂O₅ then using simple P.

(Refer Slide Time: 31:14)

Determination of available K in soil

Principle

- A large number of elements, when excited in a flame, emit radiation of characteristic **wavelength**.
- The excitation cause one of the outer electrons of neutral atoms to move to an outer orbit of a **higher energy level**, or the atoms may be excited sufficiently to lose an electron completely from the attractive force of the nucleus, where the excited atom **return to lower energy level**, the light at characteristic wavelength is emitted.

Apparatus

- **Flame photometer** with a red filter
- Pipette, volumetric flasks, and conical flask (100 ml)

The slide includes a video inset of a man speaking and logos for IIT Bombay and NPTEL at the bottom.

So, the next process is determination of available potassium in the soil. So, the principle says that a large number of elements, so generally we use the flame photometry process a large number of elements when excited in a flame emits radiation of characteristic wavelengths.

So, the excitation cause one of the outer electrons of neutral atoms to move to an outer orbit of a higher energy level or the atoms may be excited sufficiently lose an electron completely from the attractive force of the nucleus and where the excitation excited atom returns to the lower energy level the light at characteristic wavelength is emitted.

So, basically it is you know it is basically exciting and you know the outer electrons of a neutral atoms to move and outer orbit of higher energy levels. And then when it returns back to the lower energy level, then it emits the light at a characteristic wavelength that we measure that emitted light to identify the concentration of a particular element.

So, the apparatus which we generally use flame photometer with red filter and apart from that also we use pipette, volumetric flask and conical flask. So we will discuss the procedure in our next lecture, we will see how we can measure the available potassium and we will also discuss the principle of we will show how these flame photometer is used to measure the soil potassium in details and also we will also see the interpretation of the potassium results and how to interpret them into high, medium and low. So we will discuss all these in our next lecture. And so please stay tuned. And if you have any question, please feel free to post your queries in the forum. Thank you.