Soil Fertility and Fertilizers
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Lecture: 40
Organic Manures, Manufacturing, Properties, and
Fate of N, P, K and Micronutrient Fertilizers (Contd.)

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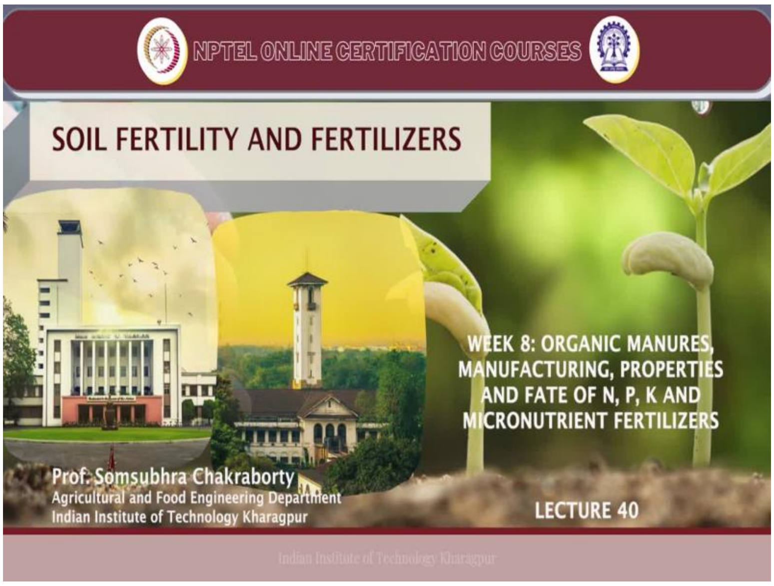

Welcome friends to this last lecture of week 8 of NPTEL online certification course of soil fertility and fertilizers. In this week, we are talking about different types of manures and also we are talking about fertilizers, classification of fertilizers, important terms related to fertilizers and also their manufacturing processes specifically the chemical fertilizers we have already seen different types of organic manure like bulky organic manure or concentrated organic manure we have seen in details about farm yard manure, compost methods of preparation of compost like Indore method, Bangalore method NADEP method, Coimbatore method we have discussed.

We have also discussed how to preserve the quality of farm yard manure and then, we have also discussed about different types of fertilizer that means classification of chemical fertilizers, what are the state fertilizer, what are the complex fertilizer what are the mixed fertilizers we have discussed also we have discussed some important terms like conditioner feeler fertilizer grade fertilizer ratio. So, also if you remember in our last lecture, we have discussed the manufacturing process of several important fertilizers like urea and then Muriate potash and then single super phosphate and so on.

So, in today's lecture, we are going to discuss about the micronutrient fertilizer because so, far we have discussed about macronutrient fertilizer today we are going to discuss about micronutrient fertilizers and we are going to recap those micronutrient fertilizers, which we have already discussed in our previous lectures. Apart from that we are going to see how to calculate the fertilizer requirement for a particular growing condition, what are the consideration and how we generally calculate the fertilizer requirement for a crop using several formulas we are going to discuss those things also.

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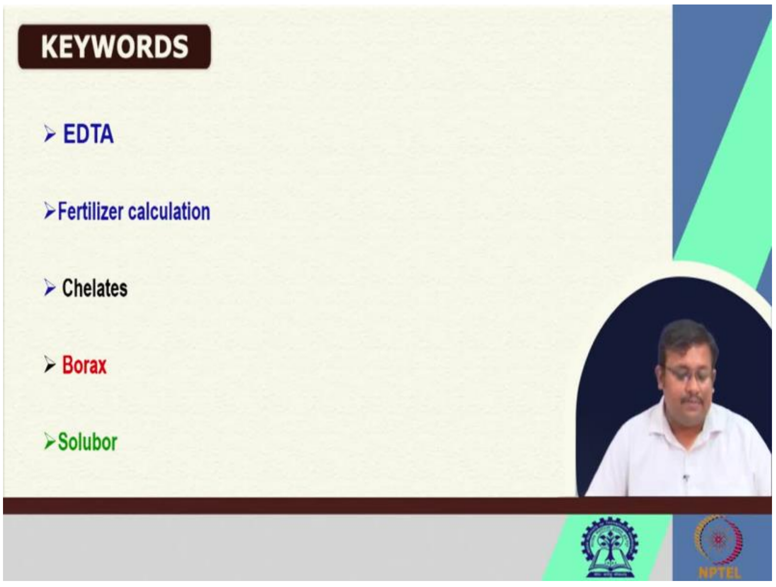

So, as I said that, these are the 2 major concepts which we are going to cover in this lecture. First of all micronutrient fertilizers and then fertilizer calculations. So, these are the keywords for this lecture EDTA, fertilizer calculation, chelates, Borax, soluble, so, we are going to discuss all of this.

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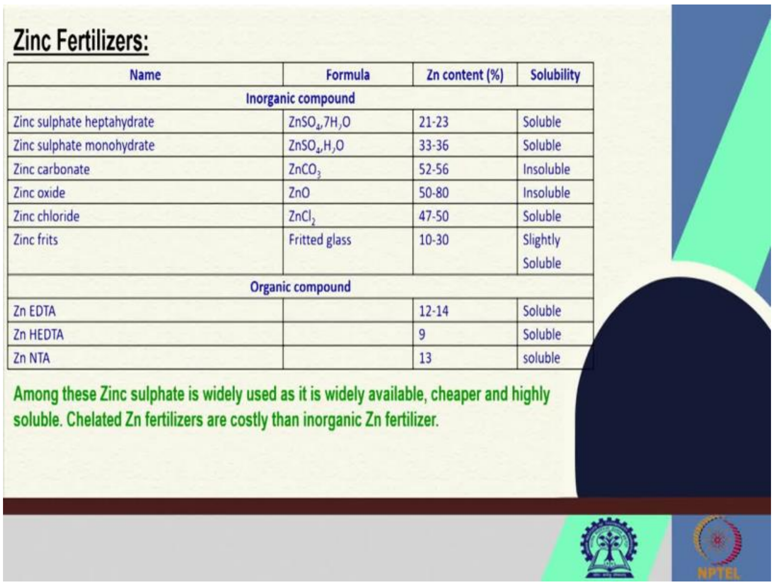

Zinc Fertilizers:

Name	Formula	Zn content (%)	Solubility
Inorganic compound			
Zinc sulphate heptahydrate	$ZnSO_4.7H_2O$	21-23	Soluble
Zinc sulphate monohydrate	$ZnSO_4.H_2O$	33-36	Soluble
Zinc carbonate	$ZnCO_3$	52-56	Insoluble
Zinc oxide	ZnO	50-80	Insoluble
Zinc chloride	$ZnCl_2$	47-50	Soluble
Zinc frits	Fritted glass	10-30	Slightly Soluble
Organic compound			
Zn EDTA		12-14	Soluble
Zn HEDTA		9	Soluble
Zn NTA		13	soluble

Now, if we consider the micronutrient fertilizers, one of the major plant micronutrient is zinc. Now, zinc fertilizers are both inorganic in nature as well as organic in nature. Organic compounds such related compounds so, you can see here in this table. zinc sulfate heptahydrate is a common zinc fertilizer, which contains 21 to 23 percent of zinc, which is soluble zinc sulfate monohydrate contained 33 to 36 percent of zinc, which is also soluble and then zinc carbonate and zinc oxide both of them are an insoluble well zinc carbonate content 52 to 56 percent of zinc and zinc oxide content 50 to 80 percent of zinc, zinc chloride is soluble content 47 to 50 percent of zinc, zinc frits, which are fritted glass, they contain 10 to 30 percent of zinc and they are slightly soluble among the organic compound or chelate compound we can see zinc EDTA zinc HEDTA and zinc NTA.

So, zinc EDTA contains 12 to 14 percent of zinc, zinc HEDTA contained 9 percent of zinc and zinc NTA content 13 percent of zinc. So, all of these chelate products are soluble in nature water soluble in nature. So, among these zincs among these fertilizer, we can see zinc sulfate is widely used as it is widely available cheaper and highly soluble. And remember that chelated zinc fertilizers are costly then inorganic zinc, so we can see that zinc we can apply both inorganic as well as in chelate form.

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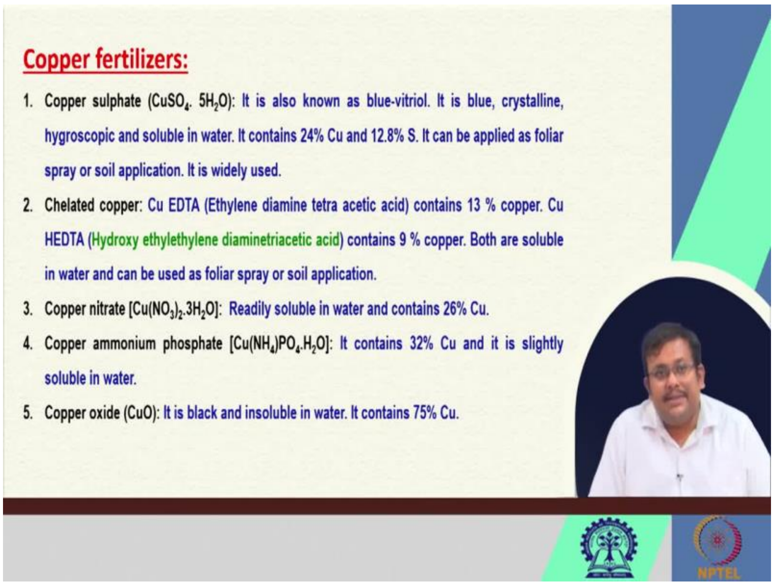

Now, let us see the copper fertilizers. Now, copper sulfate that is CuSO4 5H2O, it is also known as blue vitriol. So, it is blue crystalline hygroscopic and soluble in water it contains 24 percent of copper and 12.8 percent of sulfur and it can be applied as foliar spray or application it is generally widely used.

Now, the second fertilizer is chelated copper fertilizer or copper EDTA we know the full name of EDTA that is ethylene diamine tetra acetic acid, this chelated copper, copper EDTA content 13 percent of copper and copper HEDTA and full name of HEDTA hydroxy ethylethylene di amine tri acetic acid it contained 9 percent of copper and both are soluble in water that is copper EDTA and copper HEDTA both are soluble in water and can be used as foliar spray or soil application.

So, they can be used both as foliar spray or soil application. The third important fertilizer is copper fertilizers, copper nitrate is a chemical formula and it is readily soluble in water and contains 26 percent of copper. Fourth one is copper ammonium phosphate which contains 32 percent copper and it is slightly soluble in water. The fifth one is copper oxide it is black and insoluble in water and it contains 75 percent of copper. So, these are the major copper fertilizers, which we generally use in the crop.

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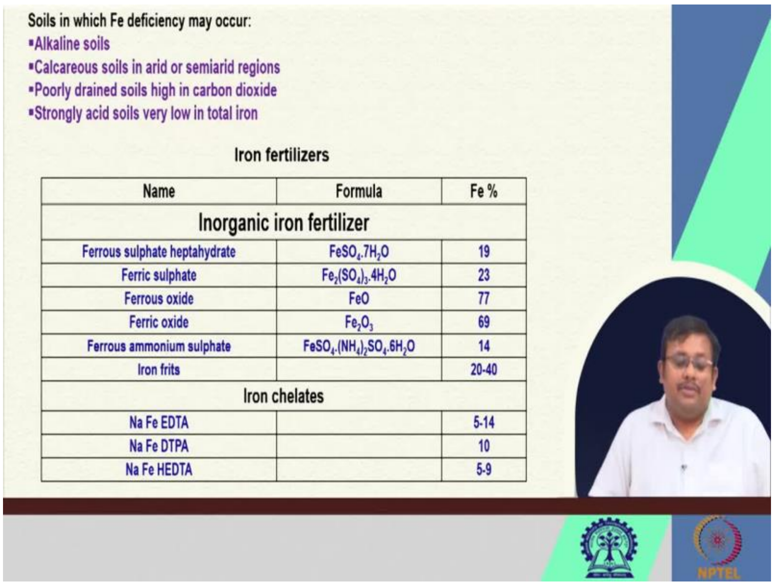

Now, third important micronutrient is iron and soils in which we can see iron deficiency or alkaline soil because iron is mainly available in acidic condition. So, in alkaline condition we can see the deficiency of iron and also in case of calcaneus soil in arid or semiarid region we can see the iron deficiency also we can see the iron deficiency in poorly drained soil high in carbon dioxide and fine also in case of strongly acid soil very low in total iron we can also see iron deficiency.

Now, there are several iron fertilizers both inorganic iron fertilizer and iron chelates among the inorganic iron fertilizer we can see ferrous sulfate heptahydrate or FeSO4 7H2O, which content 19 percent iron then ferric sulfate the formula is Fe2 So4 whole 3 4H2O which content 23 percent of iron. The third one is ferrous oxide, which is FeO and content 77 percent of iron ferric oxide contained Fe2O3… it has a chemical formula of Fe2O3 and it contains 69 percent of iron.

Then ferrous ammonium sulfate which is FeSO4 NH4 whole 2SO4 6H2O, it contains 14 percent of Iron, then Iron frits which contain 20 to 40 percent of iron. Among different organic iron fertilizer we can see Iron chelates like sodium Iron EDTA which contain 5 to 14 percent of Iron, then sodium Iron DTPA, which contains 10 percent of Iron, and then also sodium, Iron HEDTA which content 5 to 9 percent of Iron. So, you can see that Iron can be, we can apply iron both as inorganic iron fertilizer as well as organic chelates.

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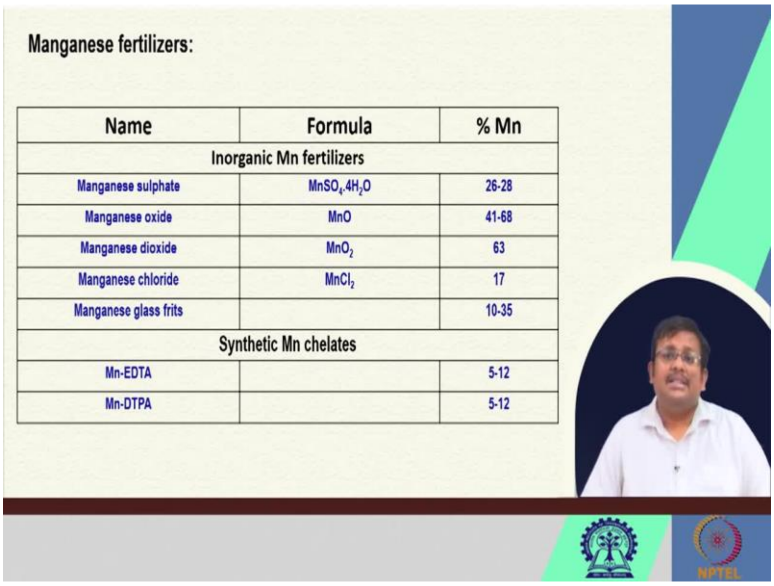

Now, if we see the manganese fertilizers, manganese fertilizers are also divided in inorganic manganese fertilizers, and synthetic manganese chelates. Now, among inorganic manganese fertilizers we can see manganese sulfate, which has the chemical formula of MnSO4 4H2O which contains 26 to 28 percent of manganese. Then manganese oxide which has the chemical formula of MnO which content 41 to 68 percent of manganese.

Then manganese dioxide, which has the chemical formula of MnO2 which contains 63 percent of manganese, manganese chloride MnCl2 content 17 percent of manganese and then manganese glass frits content in 10 to 35 percent of manganese. Among synthetic manganese chelates, we can see manganese EDTA, which content 5 to 12 percent of manganese and manganese DTPA content 5 to 12 percent of manganese also. So, you can see just like iron, we can also see this like iron zinc we also see the both inorganic manganese fertilizer as well as synthetic chelates.

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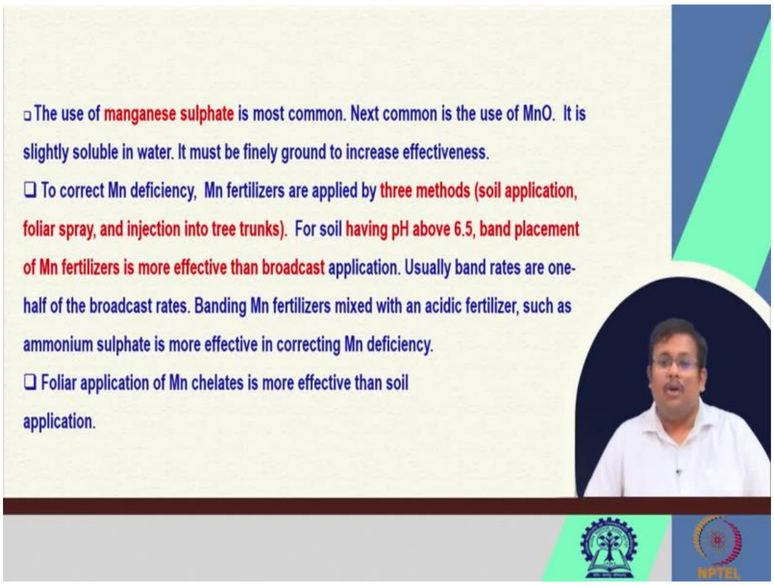

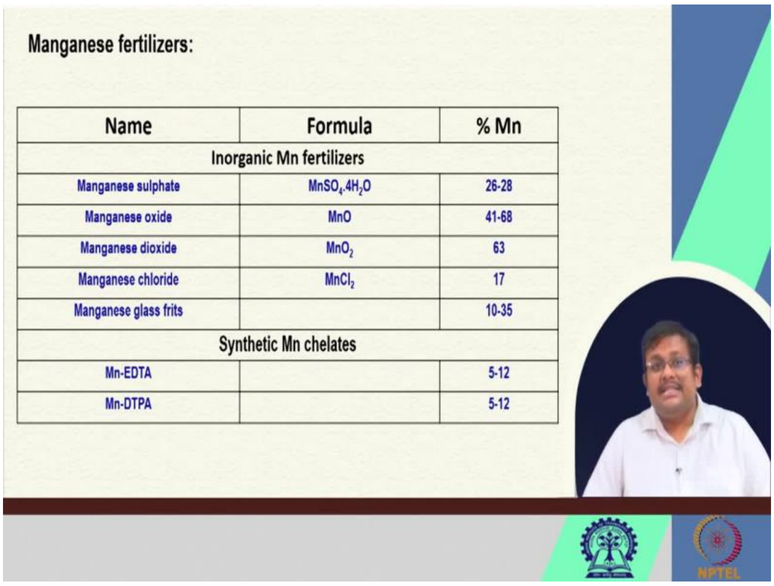
Manganese fertilizers:

Name	Formula	% Mn
Inorganic Mn fertilizers		
Manganese sulphate	$MnSO_4.4H_2O$	26-28
Manganese oxide	MnO	41-68
Manganese dioxide	MnO_2	63
Manganese chloride	$MnCl_2$	17
Manganese glass frits		10-35
Synthetic Mn chelates		
Mn-EDTA		5-12
Mn-DTPA		5-12

Now, the use of manganese sulfate is most common among all the manganese fertilizers and after this Manganese Sulfate we can see the user manganese oxide, it is MnO that is, you can see here MnO which contain 41 to 68 percent of manganese. So, this is slightly soluble in water and it must be finely ground to increase its effectiveness. Now, remember that to correct the manganese deficiency, manganese fertilizer are applied generally by 3 methods one is soil application second is foliar spray and third is injection into 3 tanks.

Now, so for soil having pH about 6.5 band placement of manganese fertilizer is more effective than broadcast because if you apply manganese in broadcast it will become unavailable in alkaline condition. Now, usually brand rates are one half of the broadcast rate. So, in that way you can save the amount of fertilizer also and you can judiciously apply the manganese fertilizer, bending manganese fertilizer mixed with an acidic fertilizer such as ammonium sulfate is more effective in correcting the manganese deficiency because manganese is mainly available in acidic condition. Now, you also need to know that foliar application manure chillers is more effective than soil application.

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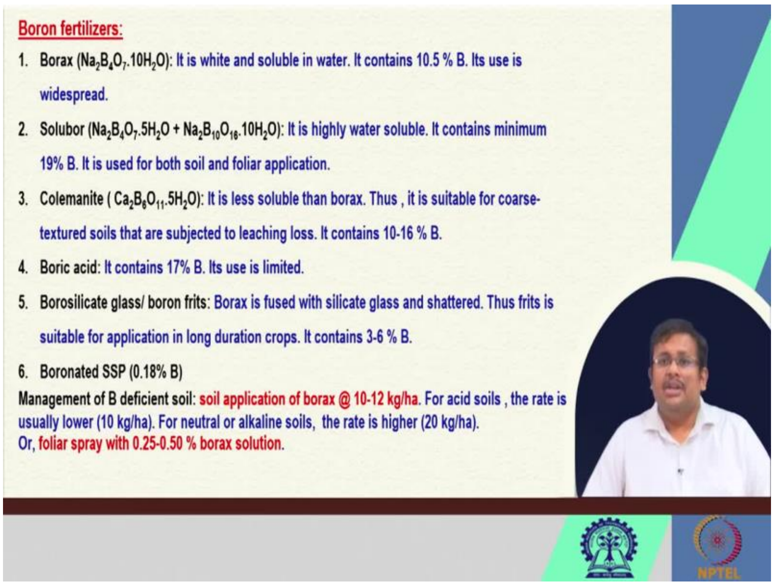

Now, let us discuss about boron fertilizers we have already discussed I am just make I am just recapitulating all these so, Borax is the major boron fertilizer which is having the formula of NA2 B4 O7 10H2O it is white and soluble in water and it content generally 10.5 percent of boron and it is widely used mostly it is most widely use boron fertilizer then comes the soluble which is highly water soluble it contains minimum 19 percent of boron it is used for both soil and foliar application.

Third is Colemanite and it is less soluble than borax. It is suitable for coarse textured soils which are subjected to leaching loss and it generally contain 10 to 16 percent of Boron. Forth one is boric acid which contains 17 percent of boron and its use is generally limited. Fifth one is borosilicate glass or boron fates. Generally, Borax is fused with silicate glass and then shattered so that is frits is suitable for application and long duration crop and this boron frits generally content 3 to 6 percent of boron and finally boronated single super phosphate which contain 0.18 percent of boron.

Now, if we consider the management of boron deficient soil, remember that soil application of borax at 10 to 12 kg per hectare, we generally recommend. Now, in case of acid soil the rate is usually lower that is 10 kg per hectare for neutral to alkaline soil the rate is generally higher that is 20 kg per hectare. Generally, for foliar spray we recommend 0.25 to 0.5 percent of borax solution.

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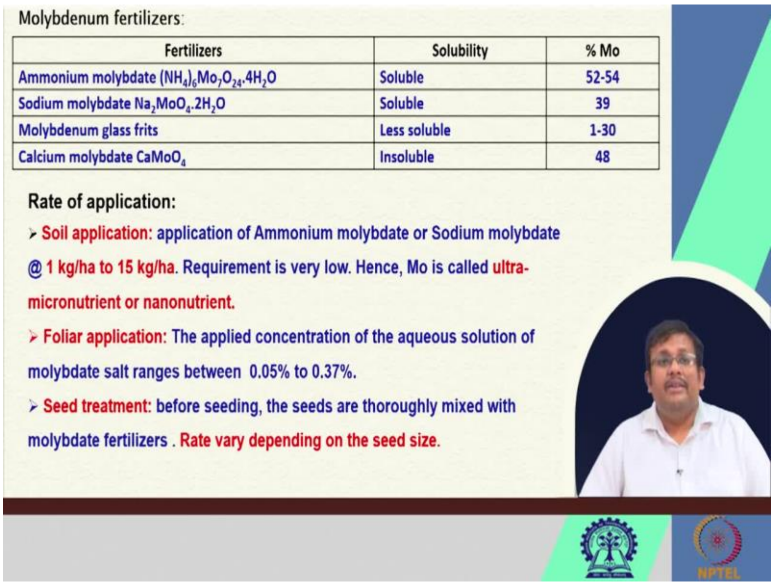

If we consider the molybdenum fertilizers, there are 4 molybdenum fertilizers majorly available ammonium molybdate, sodium molybdate, molybdenum glass frits and calcium molybdate. Well, ammonium molybdate and sodium molybdate are soluble in nature, we can see molybdenum glass frits are less soluble and calcium molybdate is insoluble in nature and all these we can see that ammonium molybdate contain highest amount of molybdenum that is 52 to 54 percent.

Now, if we see the rate of application of molybdenum, generally the soil application of ammonium molybdate or sodium molybdate is recommended at one kg per hectare or 15 kg to 15 kg per hectare. So, the range is 1 to 15 kg per hectare. So, you can see the requirement is very low. So, molybdenum is also called Ultra micronutrient on Nano nutrients sometime. Now, in case of foliar application the applied concentration of the aqueous solution of the molybdate salt ranges between 0.05 to 0.37 percent. In case of seed treatment, so, we generally before seeding the seeds are thoroughly mixed with molybdate fertilizer and rate vary depending on the seed size.

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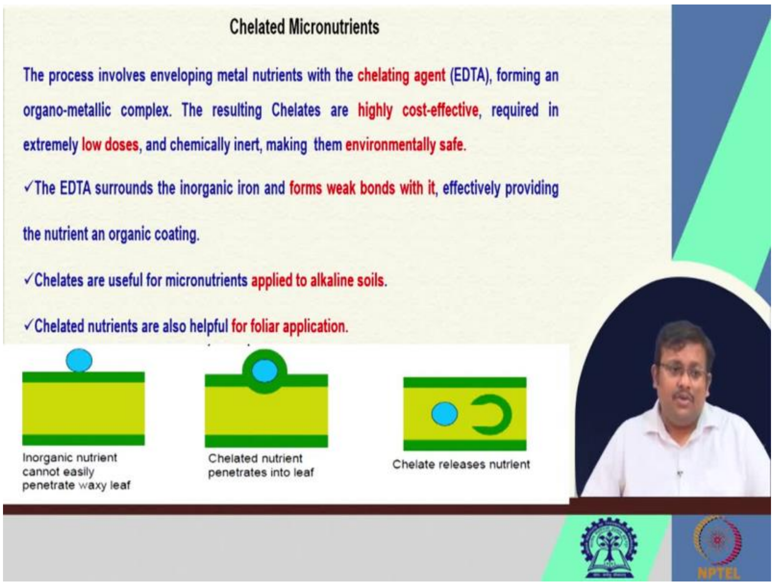

Now, we already know about Chelates and we know the examples of Chelates also, so chelated micronutrient are widely available for plant nutrition. And the process of chelation involves enveloping metal nutrients with the chelating agents for example, EDTA forming an organometallic complex and the resulting chelates are highly cost effective required in extremely low doses and chemically inert making them environmentally safe.

So, the EDTA Ethylene Diamine Tetra Acetic acid surrounds the inorganic iron and forms a weak bond with it. So effectively providing the new chain and organic coating chelates are useful for micronutrients applied to alkaline soils and chelated nutrients are also helpful for foliar application. So, here you can see that in organic nutrient generally cannot easily penetrate the waxy leaf because there is a waxy layer over the leaf but chelated nutrients easily penetrate into the leaf and after that the ligand is removed from the metal. So, this chelate released this nutrient to inside the plant cell. So, this is how chelate works.

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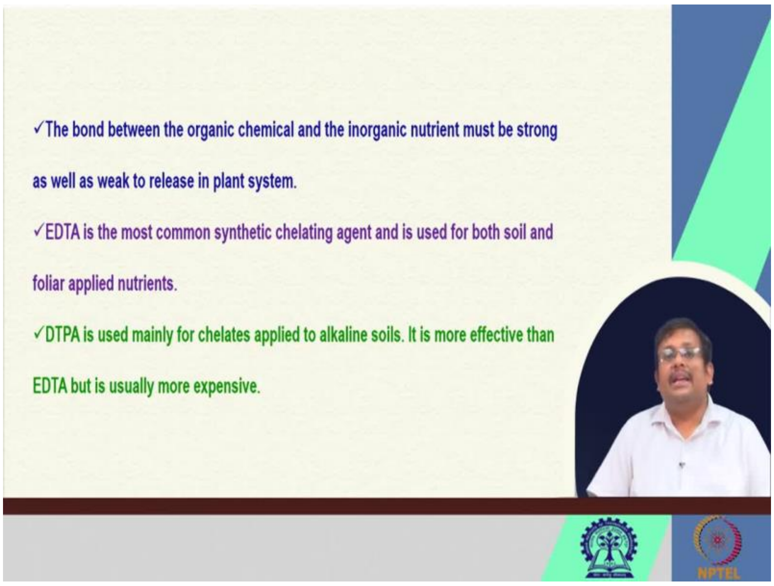

Now, the bond between this organic chemical and the inorganic nutrient must be strong as well as weak to release the plant release in within the plant system. Now, EDTA is the most common synthetic circulating agent and is used for both soil and foliar applied nutrients DTPA on the other hand, is used mainly for chelates applied to alkaline soil and it is more effective than EDTA but it is usually more expensive than EDTA. So, that is why you can see this is why we can select a particular chelating compound and after comparing their cost, because cost involvement is one of the major factor when we consider the chelated fertilizers.

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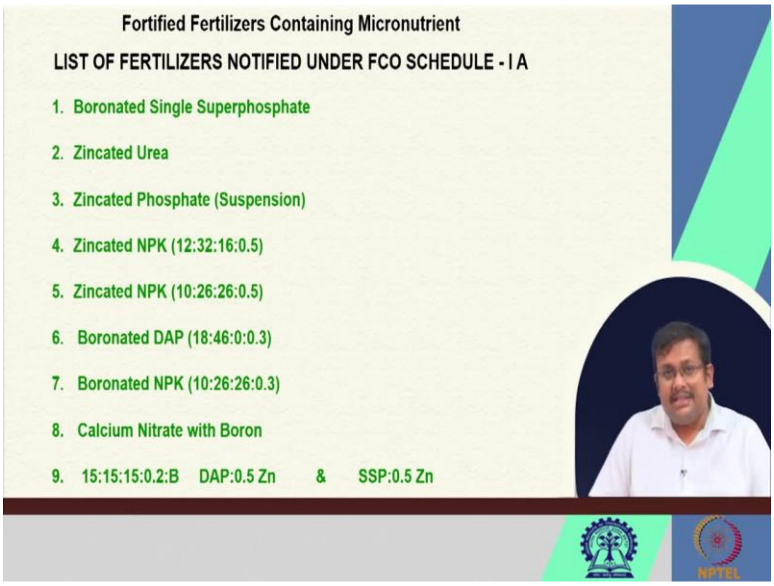

Now, if we see that, there are several fortified fertilizers, which contain micronutrient I have given here the list of list here which are notified under the fertilizer control order schedule 1A so, you can see here Boronated single superphosphate, zincated urea, zincated phosphate in the form of suspension then zincated NPK which content that is 12 percent nitrogen 32 percent P2O5 16 percent K2O and 0.5 percent of zinc, then zincated NPK that is 10 26 26 0.5.

So, 10 percent nitrogen 26 percent P2O5, 26 percent K2O and 0.5 percent of zinc then Boronated DAP in case of DAP it contained 18 percent nitrogen 46 percent P2O5 and 0 percent K2O and Boronated DAP generally contents along with these generally contain 0.3 percent of boron, boronated NPK 10 26 26 0.3, then calcium nitrate with boron and then you can see 15 15 15 0.2 for Boron DAP 0.5 zinc, and then SSP 0.5 zinc. So, these are different fortified fertilizers, which contained along with the primary nutrients, they also contain the secondary nutrients. So, this is why we call them fortified fertilizers.

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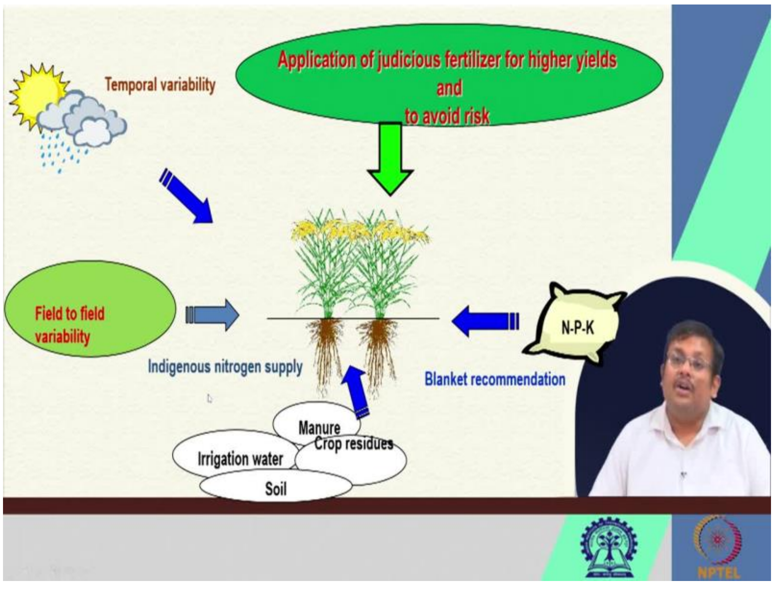

Now, as I have mentioned previously, the application of judicious fertilizer for higher yield generally depends on fertilizer application however, fertilizer application depends on both temporal variability then climatic parameters and indigenous nitrogen or nutrient supply we can see here nutrient supply from manure crop residues irrigation water and soil. So, this for nitrogen and we can see the same for the nutrients also.

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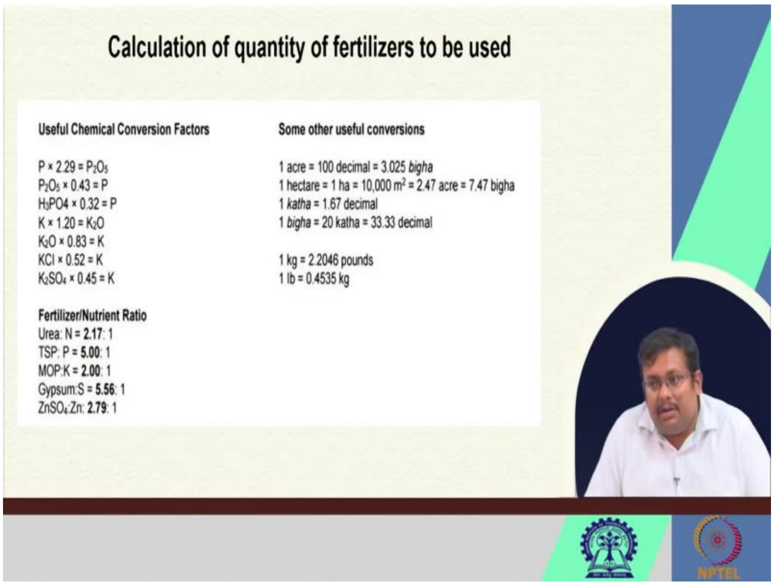

So, guys we have completed discussing about the macronutrient and micronutrient fertilizers. Now, let us discuss about how to calculate the fertilizers. Now, for that you need to remember some useful chemical conversion factors like when you multiply P with a factor of 2.29 you get the you get the P2O5, and when you multiply P2O5 with 0.43 you get p when you multiply K with 1.20 you get K2O and when you multiply K2O with 0.83 you get K similarly, you can see KCL to K K2SO4 to K conversions are given. Now, also you can see here, these are some fertilizer nutrient ratio in case of urea.

So, fertilizer nutrient ratio is 2.17 is to 1 D in case of triple superphosphate it is 5 is to 1 Muriate potash it is 2 is to 1 gypsum in case of sulfur in gypsum we get 5.56 is to 1 and in case of zinc sulfate that is zinc it is 2.79 is to 1 and remember some other useful conversion that is 1 acre is of course 100 decimal which is around 3.02 bigha of land and one hectare is 10,000 square meter, which is 2.47 acre or 7.47 bigha. 1 katha it generally is 1.67 decimal and one bigha is basically 20 katha or 33.33 decimal. So, these are some useful conversion we should remember while calculating the fertilizers. Generally, the fertilizer recommendations are given in hectare basis. However, we can calculate it according to our field size.

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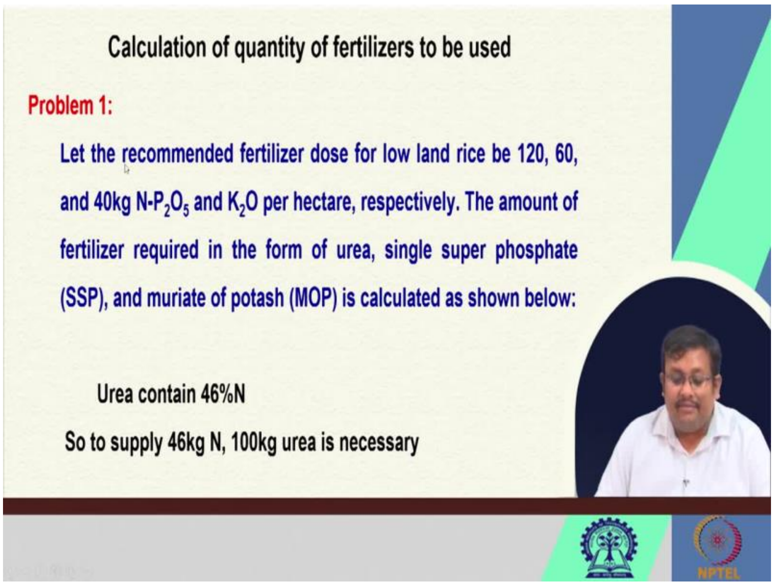

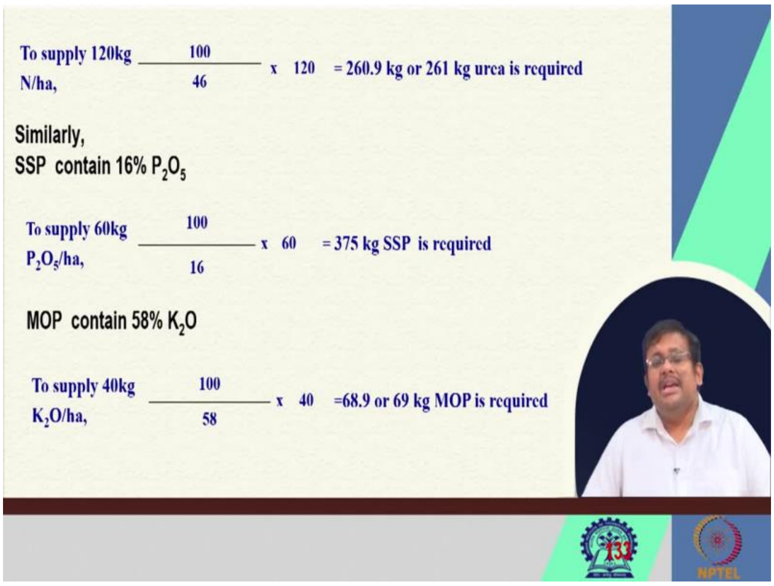

So, let us see one example. So, problem one says that let the recommended fertilizer dose for lowland rice be 120, 60 and 40 kg N P2O5 and K2O per hectare respectively the amount of fertilizer required in the form of urea single super phosphate and Muriate of potash is calculated so, we know that urea content 46 percent nitrogen so that means to supply… when we apply 100 kg of urea in the field that supply 46 kg of nitrogen. So, to since our recommended dose is 120 kg of nitrogen to supply these 120 kg of nitrogen, we need to apply 260 kg of or 100 by 46 into 120 that is 260.9 that is 261 kg of urea.

Similarly, if we consider the signal superphosphate you know that single super phosphate contains 16 percent of P2O5. So, our recommended dose is 60 percent or 60 kg P2O5 per hectare. So, to supply the 60 kg P2O5 we require 375 kg of single super phosphate. If we want to meet the requirement using a straight fertilizer like single super phosphate.

Now, in case of potash we know that Muriate of potash content 58 percent to 60 percent K2O so, to supply this 40 kg K2O, to supply this 40 kg K2O per hectare we require generally according to our it is 120 kg 60 kg and 40 kg so, 120 kg is nitrogen requirements 60 kg is phosphate requirement and in case of potash it is 40 kg requirement. So, 100 by 58 by 40 so, we get 68.9 or 69 kg of MOP sometime you will see that people are using 60 percent K2O that is also okay in case of MOP.

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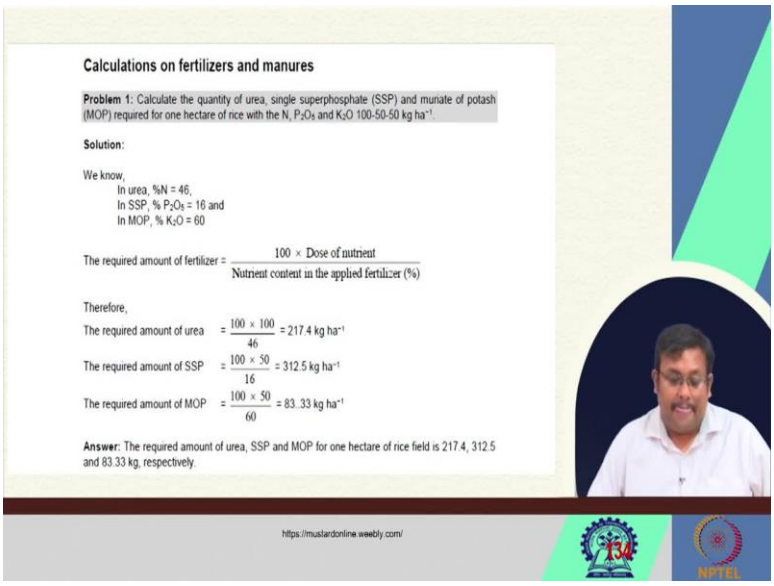

Just here also here you can see that they are considering the percent K2O as 60 in case of MOP So, both of them are fine, you can use either, generally we use 60 percent. So, here the problem is calculate the quantity of urea single super phosphate and mutator potash required for one hectare of rice with the nitrogen P2O5 and K2O 100 50 50 kg per hectare. So, we know that in urea percent of nitrogen is 46 in single super phosphate percent P2O5 is 16 and in MOP percent gateway is 60. So, here you can see they are taking 60 kg I mean 60 percent K2O in case of MOP.

So, the declared amount of fertilizer is 100 multiplied by those of nutrient by nutrient content in the applied fertilizer. So, this is this simple formula. So, here for nitrogen we get 100 by 46 into 100 because our recommended dose is 100. So, 217 kg per hectare. So, the required similarly for SSP we can calculate 100 by 16 multiplied by 50 that is 312 and required amount of MOP is 100 by 16 to 50 that is 83 kg per hectare. So, the required amount of urea SSP and MOP for one hectare of land is 217.4 312.5 and 83.33 kg respectively.

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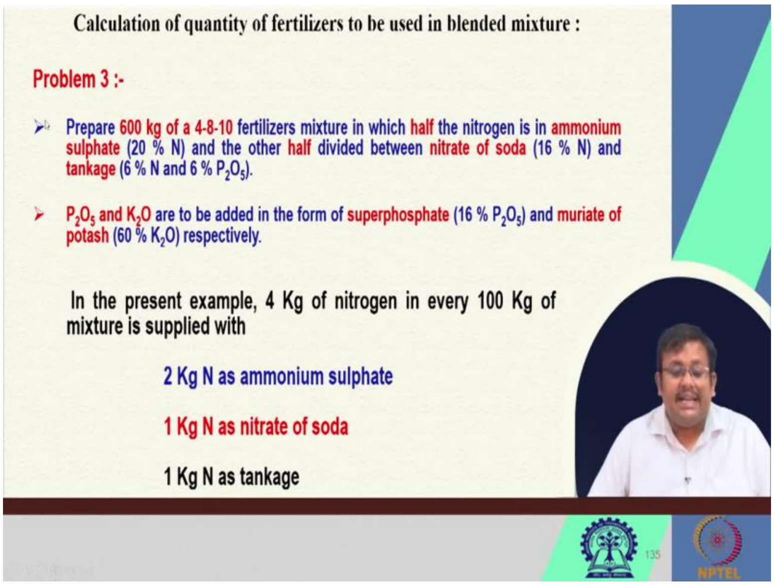

Now, another problem is there is a problem with a blended mixture fertilizer. So, the question is prepared 600 kg of 4 8 10 So, this is a grade, fertilizer grade 4 kg nitrogen, 8 kg of P2O5 and 10 kg of K2O. So, 4 8 10 fertilizer mixture in which half of the nitrogen is in ammonium sulfate, which contained 20 percent nitrogen and the other half divided between nitrate of soda that is 16 percent, nitrogen and tankage which contains 6 percent nitrogen and 6 percent P2O5. Now, P2O5 and K2O are to be added in the form of superphosphate which contains 16 percent P2O5 and Muriate of potash which contains 60 percent K2O.

Now, in the present example remember our recommended dose is 4 kg of nitrogen and according to our problem we have to for 4 kg of nitrogen in every 100 kg of this mixture is supplied with 2 kg of ammonium sulfate and then 2 kg nitrous as ammonium sulfate, so, half of it should come from the ammonium sulfate and 1 kg will come 1 kg of nitrogen will come from nitrate of soda and 1 kg of nitrogen will come from tankage. So, let us calculate.

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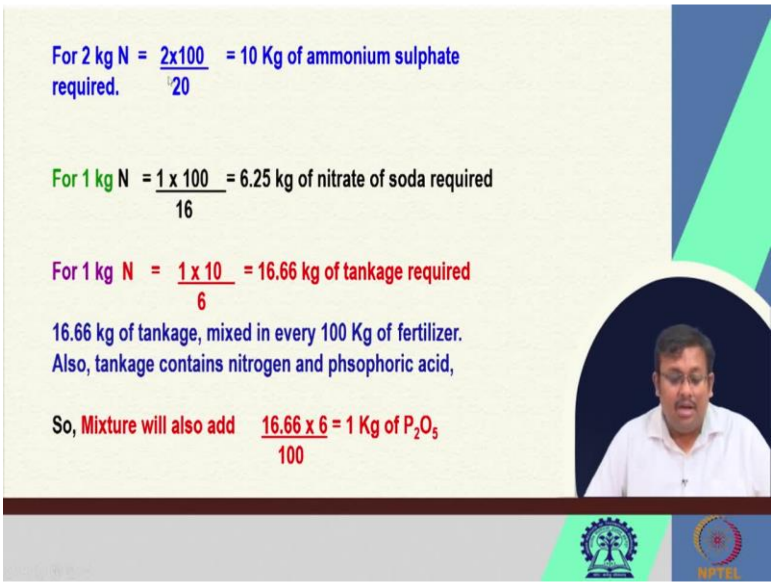

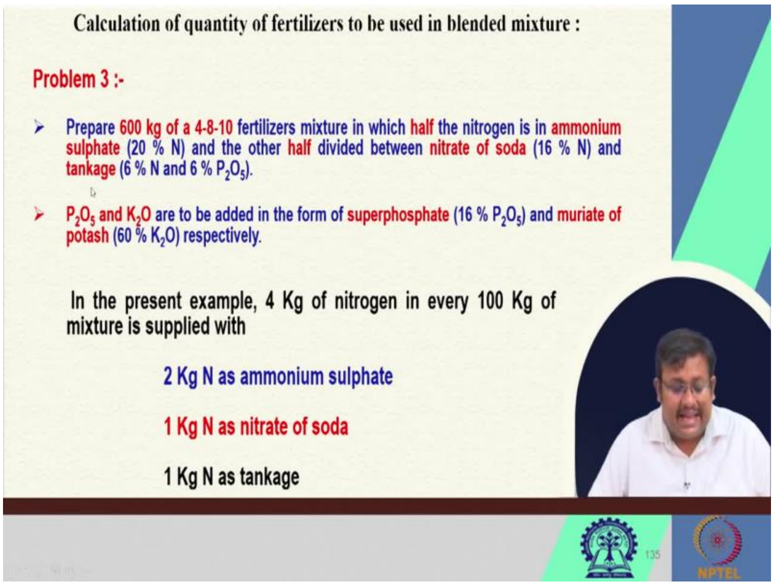

So, for 2 kg nitrogen we require 10 kg ammonium sulfate same formula, we know that ammonium sulfate content 20 kg of nitrogen so to supply 2 kg of nitrogen we require 2 into 20 so, from 100 kg of ammonium sulfate we get 20 kg of nitrogen. So, for getting 2 kg of nitrogen we require 10 kg of ammonium sulfate. Similarly, for 1 kg of nitrogen from the nitrate of soda we require 1 by 16 into 100 so that is 6.25 kg and for 1 kg of nitrogen from tankage we require 16.66 kg. So, we record 16.60 kg of tankage mixed with every 100 kg of fertilizer. So, also tankage contains nitrogen and phosphoric acid.

So, we have already we already know that for to supply the required amount of nitrogen, we required 16.66 kg of nitrogen of tankage. Now, we have to calculate how much P2O5 is supplied by that 16.66 kg of tankage. Now, we know that so this mixture that if we go to the question is it already says that the tankage contains 6 percent of P2O5. So, the 16 percent of 16.66 kg of tankage will contain 1 kg of P2O5. So, 1 kg of P2O5 is being already supplied by this tankage.

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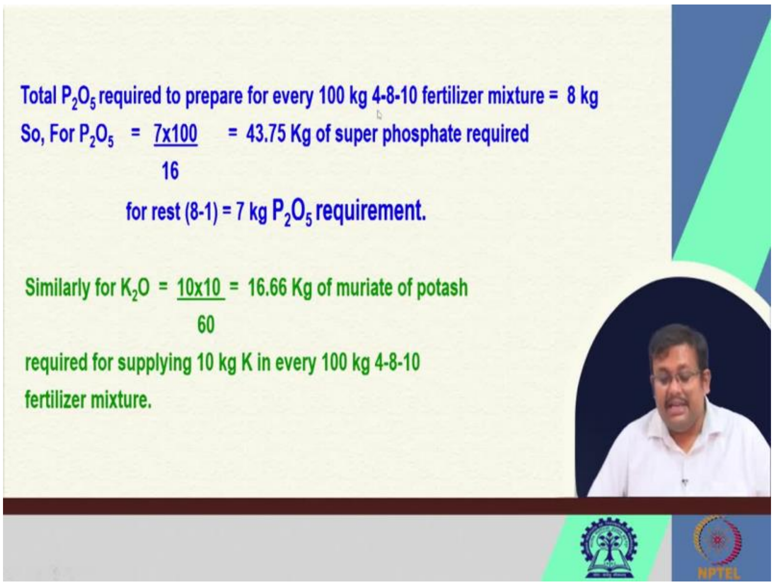

Now, the total P2O5 requirement to prepare for every 100 kg is generally 4 8 10 fertilizer mixture. So, generally 8 kg. So, among these 8 kg, tankage has already supplied 1 kg. So, the rest 7 kg has to be supplied through single superphosphate. Now, we know in case of single superphosphate it contain 16 percent of P2O5.

So, say for 7 kg of P2O5, we require 43.75 kg of superphosphate So, we require 43.75 kg of superphosphate similarly, for K2O we require 10 by 16 into 10 that is 16.66 kg of MOP. So, this is required for supplying this 10 kg of K2O in 100 kg or mixed fertilizer so, once we calculate all these.

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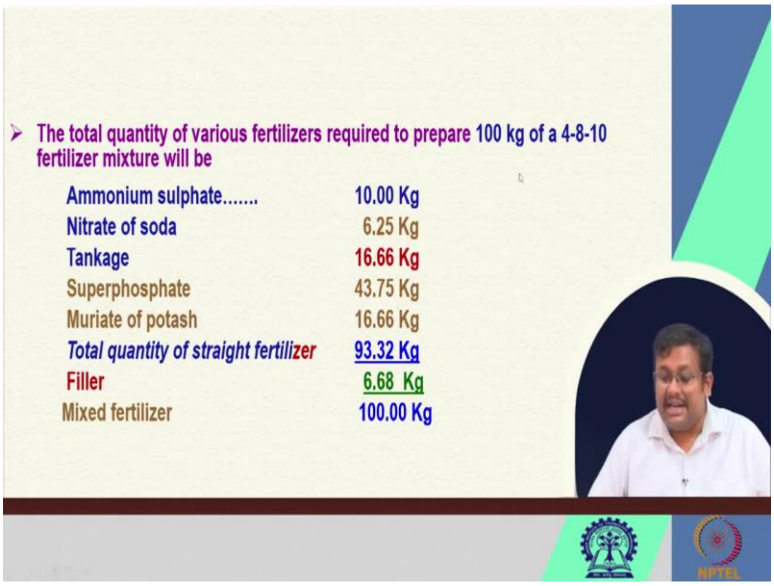

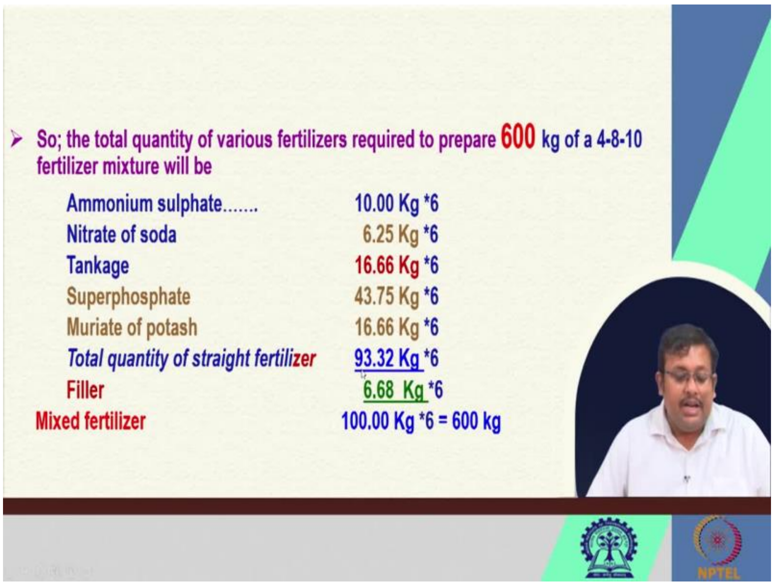

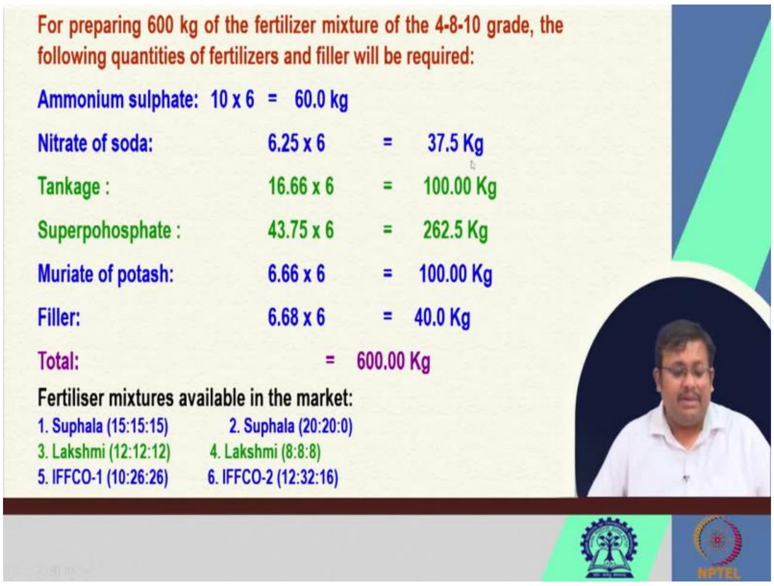

So, the total quantity of various fertilizers required to prepare this 100 kg of these 4 8 10 fertilizer mixtures we will be ammonium sulfate 10 kg nitrate of soda 6.25 kg, tankage 16.66 kg superphosphate 43.75 kg and Muriate of potash 16.66 kg. So, the total quantity of the state fertilizer is 93.32 kg. So, you will know that to create these 100 kg volume pickup or weight makeup, we need to add the 6.68 kg of filler materials. So, we require 6.68 kg of filler material.

Now, the total quantity of various fertilizer required to prepare 600 kg of these 4 8 10 fertilizer mixtures will we just have to multiply with 6 and ultimately, we can get this finally, result 37.5 kg of… so 60 kg of ammonium sulfate a nitrate of soda 37.5 kg tankage 100 kg superphosphate 262.5 kg Muriate of potash 100 kg filler 40 kg total 600 kg.

Now, remember guys in the fertilizer mixture which are available in the market, Indian market are mainly Suphala which content 15 15 15 with the fertilizer grid and Suphala 20 20 0 then Lakshmi 12 12 12, Lakshmi 8 8 8, IFFCO 1 that is 10 26 26 and IFFCO 2 that is 12 32 16. So, these are the fertilizer mixture which are commonly available in Indian market.

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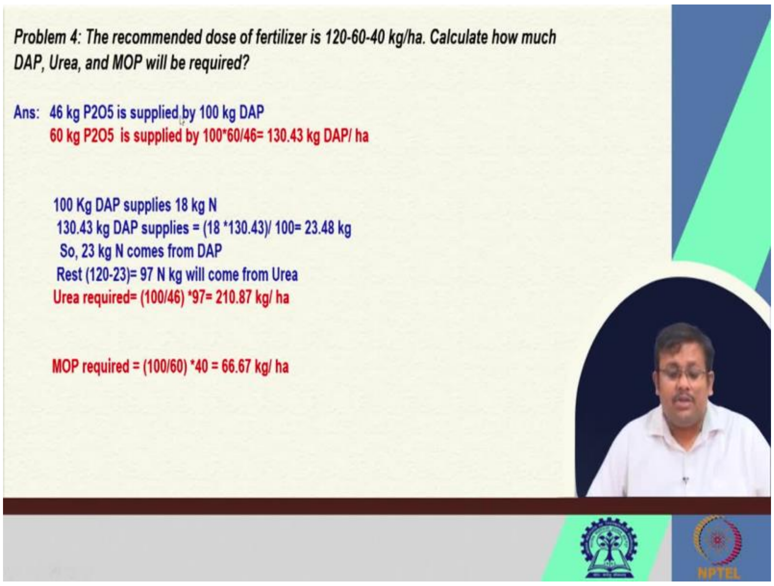

Another problem is if the recommended dose of fertilizer is 120 60 40 kg per hectare, then calculate how much DAP urea and MOP will be required. Now, first we calculate from DAP because it is a complex fertilizer. So, we already know the DAP contain 18 percent of nitrogen and 46 percent of P2O5. So, let us first calculate from the P2O5. So, we know that 46 kg of the P2O5 is supplied by 100 kg of DAP. So, our requirement is 60 kg so the 60 kg of the P2O5 will be supplied by 100 into 60 by 46, that is 130.43 kg of DAP.

So, we have first calculated our DAP requirement based on our phosphate requirement. Now, remember that in the DAP apart from this phosphate we also have 18 percent of nitrogen. So, we know 100 kg of DAP contains 18 kg of nitrous and so, this 130 kg of DAP will contain this 23.48 kg of nitrogen also so, these 23 kg of nitrogen comes from the DAP our requirement is total 120 kg.

So, the rest of the requirement is 120 minus 23 that is 97 kg. So, this 97 kg of nitrogen should be supplied by the nitrogenous fertilizer, what is the nitrogenous fertilizer urea is a nitrogenous fertilizer. So, the urea requirement is 100 by 46 into 97 that is 210.87 kg per hectare. And finally, MOP required is 100 by 16 into 40 that is 66.67 kg per hectare. This is how we calculate the fertilizer requirement when there is a compound fertilizer.

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Now, the last problem is if a soil is having CEC of 20 milliequivalent per 100 grams soil and it has calcium obtained milliequivalent per 100-gram magnesium or 5 milliequivalent for 100-gram potassium of 2 milliequivalent for 100 gram and sodium of 1 milliequivalent for 100 gram calculate calcium magnesium potassium sodium in kg per hectare, 1 hectare of soil we know 2.2 kg per hectare in soil.

So, one we know that for calcium it is contained 1 milliequivalent per 100 gram that is 20 milligram per 100 gram 1 milliequivalent of calcium means 20 milligram per 100 gram. So, 20 milligram per 100 gram means in 1000 gram or kg we have 200 milligram, so, that means 200 ppm, then we have to multiply 200 into 2.24 so, ppm multiplied by 2.24 gives us the kg per hectare. So, this is how we calculate the kg per hectare content of calcium.

Similarly, for magnesium that is one milliequivalent 12 mg and then similarly you can calculate the content of magnesium in kg per hectare and similarly for potassium and similarly for sodium. So, this is how you calculate the concentration of these elements in kg per hectare.

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Okay guys, so, these are the differences which I have used. I hope that you have learned how to calculate the fertilizer requirement, if possible. We will also discuss some more examples in our upcoming lectures. And so, let us meet in our next week of lectures to discuss more about fertilizer control and how to maintain the fertilizer quality and so on. So, we will discuss all these in our next week of lectures. Thank you.