Soil Fertility and Fertilizers
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Lecture 43
Fertilizer Quality Control, Fertilizer Adulteration and Fertilizer Testing (Contd.)

Welcome friends to this lecture number 43 of NPTEL online certification course of Soil Fertility and Fertilizers. In this week we are discussing about fertilizer quality control, fertilizer adulteration and fertilizer testing. Now, in the previous lectures we have discussed about slow release fertilizer, controlled release fertilizers; and also we have discussed about the customized fertilizers. In the last lecture we have discussed mostly on customized fertilizer; what are the requirements of customized fertilizers? How the customized fertilizer can meet the crop requirement of a particular place?

And how why farmers prefer the customized fertilizer? What are the process of making the customized fertilizers we have already discussed. Now, we are going to discuss some of the other aspects of fertilizer quality, and some other aspects of fertilizer quality control, and fertilizer testing in this lecture. Now, in this lecture the following concepts which we are going to cover.

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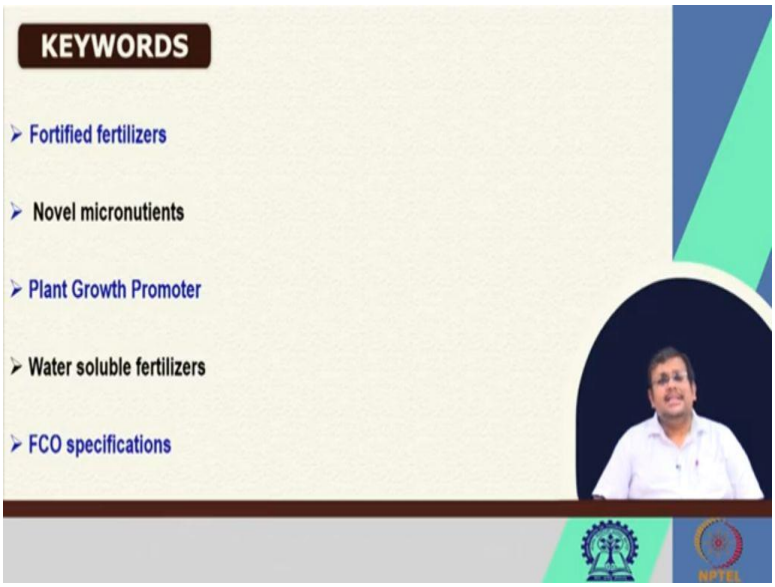

Bio-release smart micronutrients, and then fortified fertilizer containing micronutrient. We are going to learn about novel micronutrient formulations, then plant growth promoter as biostimulants, and fortified zinc and boron fertilizers. So, these are some of the concepts which we are going to cover in this lecture. These are some of the keywords of this lecture fortified fertilizers, novel micronutrients, plant growth promoter, water soluble fertilizers, and FCO specifications. So, these are some of the keywords which we are going to discuss in details in this lecture.

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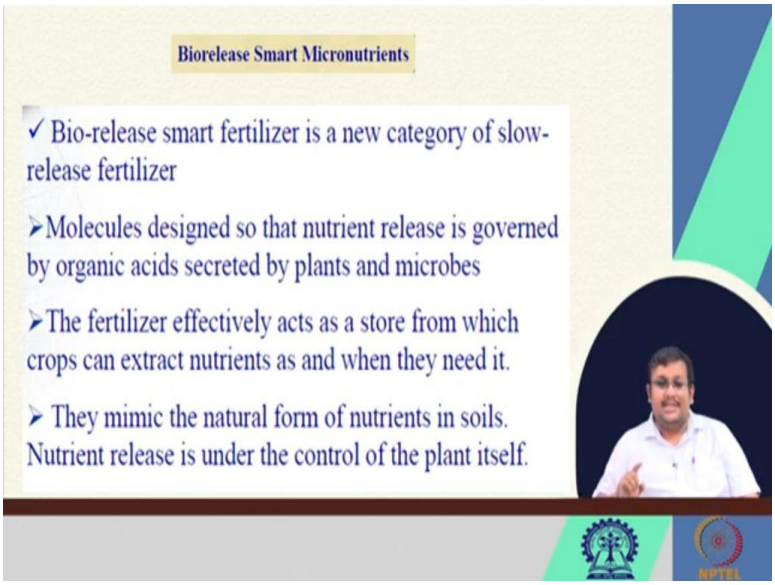

Now, let us first discuss bio-release smart micronutrient. So, bio-release smart fertilizer is a new category of slow release fertilizer. We already know what is slow release fertilizer. Slow release fertilizer is a fertilizer that is release the plant available form of fertilizer or nutrient in

a very controlled or slow manner. So, that we can increase the fertilizer use efficiency, and we can ensure the particular nutrient in the soil for the extended period of time. Now, bio-release smart fertilizer is a new category of slow release fertilizer. Molecules designed in this bio-release smart micronutrients. the molecules are designed so that the nutrient release is governed by organic acids secreted by plants and microbes.

You know that in the soil, in the rhizosphere the plant roots generally they release some of the exudates or organic acids, which can react with these molecules to release the nutrients in a controlled manner. So, not only these organic acids are secreted by the plants, but also these organic acids are secreted by the microbes. So, these micronutrient formulation so these micronutrient fertilizers, the release of these micronutrient in the plant available form is dependent on its reaction with the acids secreted by the plants and microbes. Now, the fertilizer effectively acts as a store from which crops can extract nutrient as and when they need it.

And they mimic, so basically what happens? So, the fertilizer generally effectively acts as a store and, and crops can extract these nutrients when they need by these by by the by these kind of reactions. So, the mimic, they mimic the natural form of nutrients in soil, and nutrient release is under the control of the plant itself. So, generally these reaction mimic the natural form of nutrients in soil. And nutrient release from these molecules is under the control of the plant itself; because, the nutrient release is dependent on the reaction which is mediated by the plant root exudates, or organic acids secreted by the plant roots.

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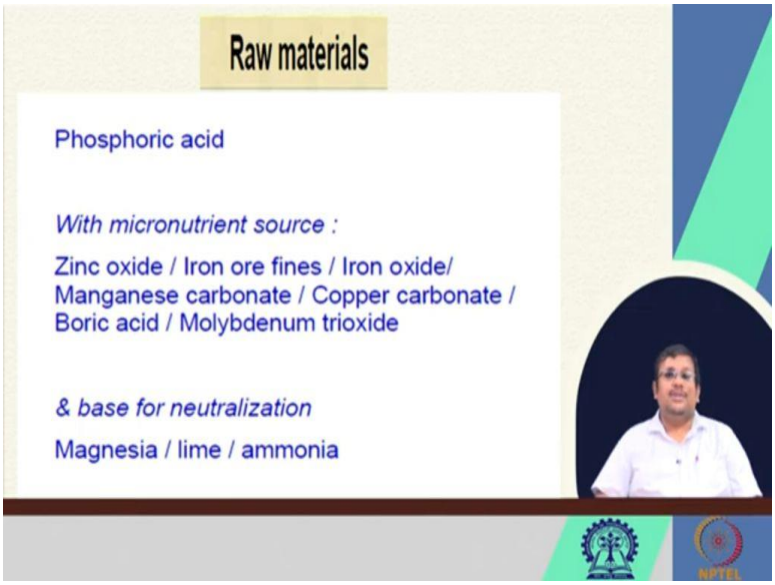

Now, what are the raw materials? So, for these by for these bio-release smart micronutrients, the raw materials are phosphoric acid; and (wish) we should have also the micronutrients source. What are the mitochondrial source like zinc oxide, iron ore fines, iron oxides, manganese carbonate, copper carbonate, boric acid, and molybdenum trioxide; so, these are the raw materials. Apart from that there are some bases for neutralization; what are those bases? Magnesia, lime, ammonia; so, these are the bases which are there as raw materials.

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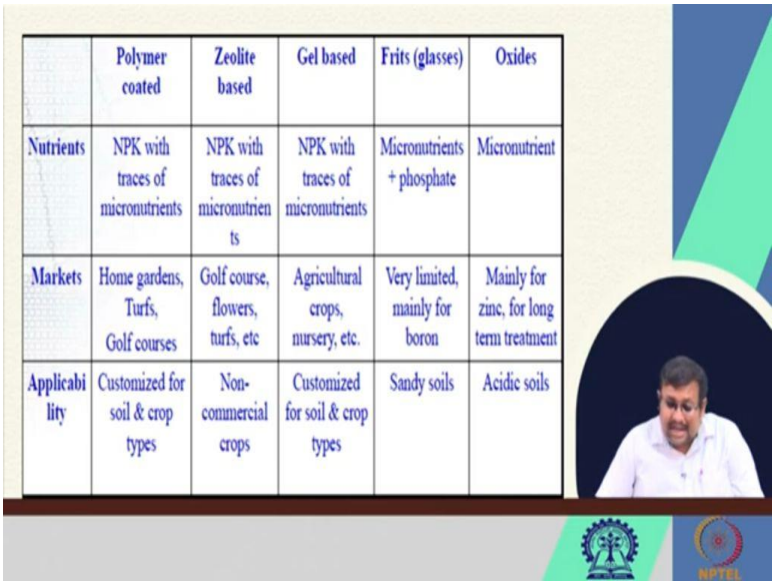

Now, let us see some examples. So, if we consider the polymer coated bio-release nutrients. So, we can see NPK with traces of micronutrients; and we can apply them for home gardens, turfs and golf courses. And applicability is basically customized for soil and crop types. If they are zeolite based, we can have NPK with traces of micronutrients. We can also apply them in the golf course, flower, turfs et-cetera; and they are basically for non-commercial crops. Then, gel based formulations are there, fertilizers are there, which are basically NPK with traces of micronutrients.

They are basically applied for available for agricultural crops, nursery; and they are customized for soil and crop types, different soil and crop types. Frits or glasses, they are basically mixture micronutrients plus phosphate. Their market is very limited mainly for boron, some other market is there; and they are applicable in sandy soils. And oxides are there which contain mainly the micronutrients; they are mainly for zinc for long term treatment, and basically they are useful for acidic soils. So, these are some of the formulations which are available. And nutrients, you my have discussed the nutrients, markets, and applicability. You can see most of them are available for a home gardens, golf

course, and flowers, and agricultural crops. And however the frits or the glasses are very; their availability in the market is very limited.

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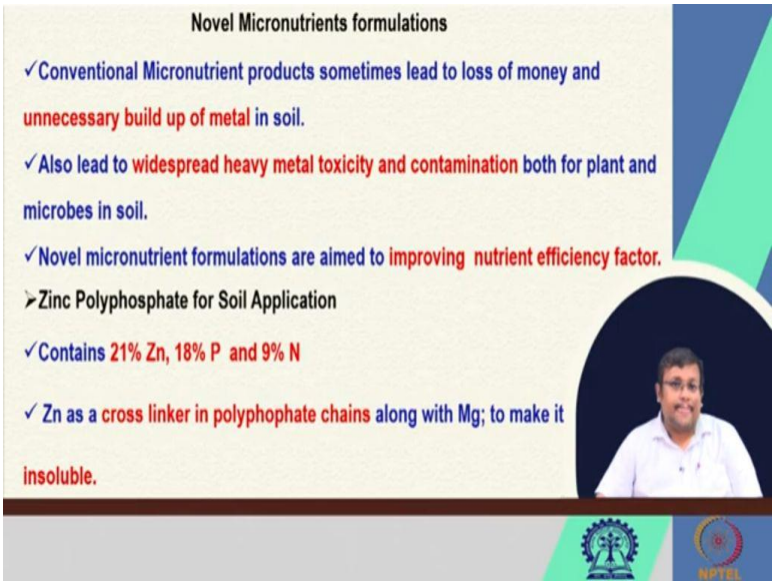

Now, let us see some novel micronutrient formulations. Now, we know that conventional micronutrient products sometimes lead to loss of money and unnecessary build up of metal in soil. And they can also lead to widespread heavy metal toxicity and contamination; both for plant and microbes in soil. So, novel micronutrient formulations are aimed to improve nutrient efficiency factor. For example, let us discuss zinc polyphosphate for soil application. Now, zinc polyphosphate, we have 21 percent zinc, 18 percent phosphorus, and 9 percent nitrogen. And here zinc as a cross linker in polyphosphate chain along with magnesium to make it insoluble. So, in this zinc polyphosphate, zinc acts as a cross linker in the polyphosphate chain and; and render it in insoluble in nature.

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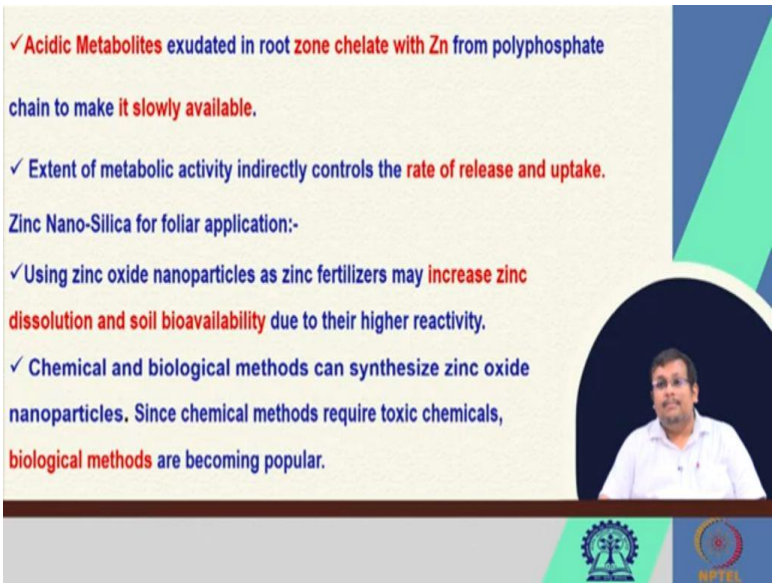

Now, acidic metabolites, what are the acidic metabolites? When there are different types of acidic metabolites exudates, exudated by the by the roots of the plant; so, when they are secreted by the plant root, these are organic chemicals, these are organic molecules. So, they act as chelate, and they can bind these zinc cation from polyphosphate chain to make it slowly available. Now, the extent of metabolic activity indirectly controls the rate of release and uptake. So, these as the metabolic activity will increase, the acidic metabolites will be released; and they will acts as a chelating agent or ligand for chelating the zinc, and then it will be available to the plant.

So, so this is how the these, these micronutrient specific micronutrient formulation basically works. Now, let us see zinc nano-silica for foliar application. Now, using zinc oxide nanoparticles as zinc fertilizer may increase zinc dissolution and soil bioavailability due to their higher reactivity. So, what happens when you apply the zinc oxide nanoparticle as zinc fertilizer? They can increase the zinc dissolution and zinc availability to the plants; because the zinc oxide nanoparticles have higher reactivity. Chemical and biological methods can also synthesize zinc oxide nanoparticles.

Since, chemical methods required toxic chemicals, biological methods are becoming more popular. Now, let us see how they do that.

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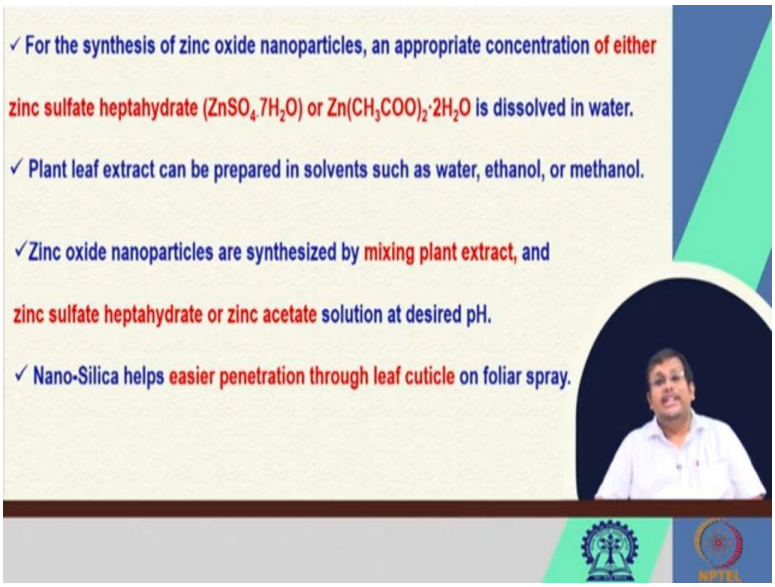

Now, for the synthesis of zinc oxide nanoparticles, an appropriate concentration of either zinc sulfate heptahydrate, or the zinc acetate is dissolved in water. Now, apart from that plant leaf, we need plant leaf extract. So, plant leaf extract can be prepared in solvents such as water, ethanol or methanol. Now, these zinc oxide nanoparticles are synthesized by mixing the plant extract which you have already prepared in water, ethanol, or methanol; and zinc sulfate heptahydrate or zinc acetate solution at desired pH. Now, nano-silica helps easier penetration through leaf cuticle on foliar spray.

So, this is how these particular zinc nano-silica formulation is developed for foliar application; remember this is for foliar application. And since nano-silica is there, it helps in easy penetration through leave cuticle during the foliar application.

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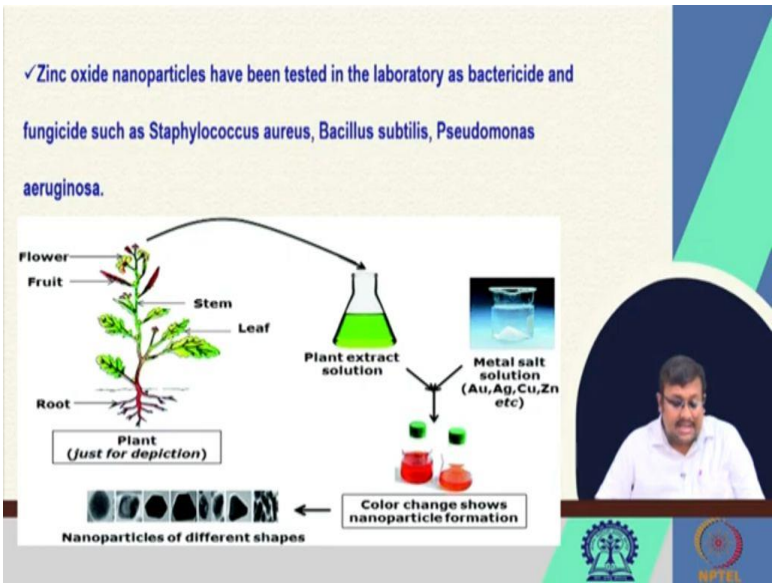

Now, the zinc oxide nanoparticles have been tested in the laboratory as bactericide and fungicide such as Staphylococcus aureus, Bacillus subtilis, and Pseudomonas aeruginosa. So, you can see here, first of all we are extracting the plant extract; so, this is a plant extract solution. And then we are mixing it with the metal salt solution like silver, then the gold, then copper, zinc et-cetera; and then we can see the the nanoparticles there. So, nanoparticle formula formulations are there, and these nanoparticles will act as a source of the nutrients. So, this is how these zinc oxide nanoparticles basically work.

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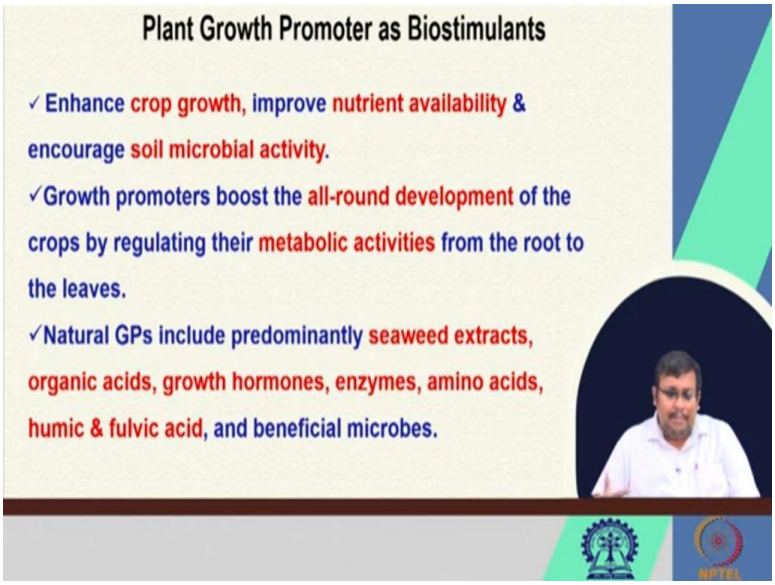

Now, let us discuss plant growth promoter as biostimulants. Now, enhance crop growth, improve nutrient availability, and encourage soil microbial activity; these three are the major

objectives of plant growth promoter. Now, growth promoters basically boost the all-round development of the crops by regulating their metabolic activities from the root to the leaves. So, growth promoter basically help in the development of the crops by (reveal) by regulating their metabolic activities. Natural growth promoters include predominantly seaweed extract, organic acids, growth hormones, enzymes, amino acids, humic acid and fulvic acid, and beneficial microbes.

So, when these beneficial microbes are there in the soil, they enhance the nutrient availability; and as a result, they can also improve the metabolic activities for better growth of the crop.

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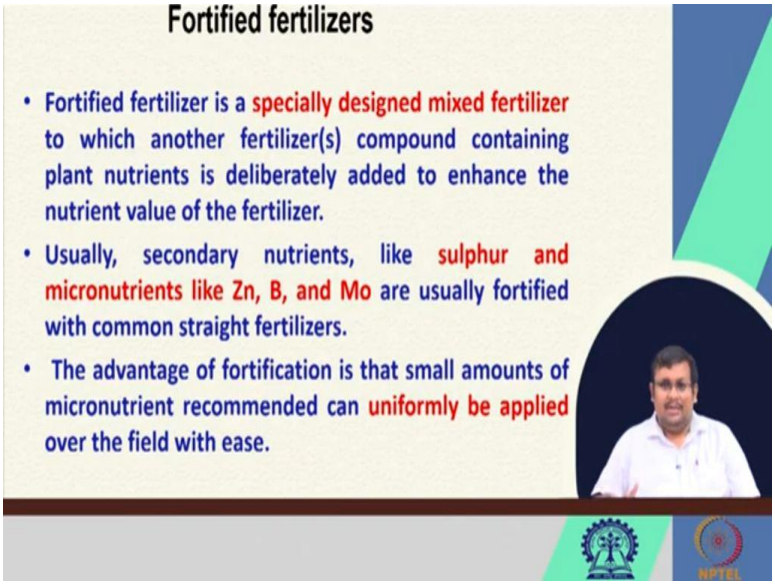

So, let us also discuss the fortified fertilizers. Now, definition of fortified fertilizer is, it is a specially designed mixed fertilizer to which another fertilizer or more than one fertilizer compound, containing plant nutrient is deliberately added to enhance the nutrient value of the fertilizer. Usually, secondary nutrients like sulphur and micronutrients like zinc, boron and molybdenum are usually fortified with the common straight fertilizer. Why we applied the fortified fertilizers? So, the advantage of fortification is that small amounts of micronutrients recommended can uniformly be applied over the field with ease.

Some fertilizer elements like boron which are required in very small quantity; now, it is difficult for the farmers to apply them. And physical application of those boron fertilizers in such a small quantity in a large area is always problematic. So, it is always better to use it as a fortified fertilizer, where it can physically mix with straight fertilizer and then apply uniformly. So, that is the major advantage of this fortification.

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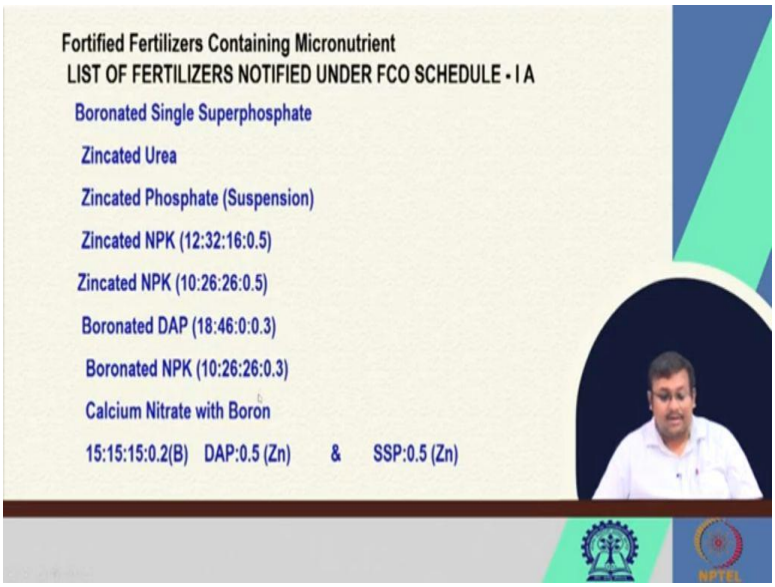

Now, fortified fertilizer containing micronutrients. You can see some lists of fertilizer notified under the fertilizer control order Schedule-1A. Boronated single superphosphate is there, zincated urea is there, zincated phosphate in the suspension form, then zincated NPK 10; sorry, 12, 32, 16, 0.5. then, zincated NPK 10, 26, 26, 0.5; boronated DAP 18, 46, 0, 0.3. Boronated NPK 10, 26, 26, 0.3; calcium nitrate with boron, we can see 15, 15, 15, 0.2. And then DAP with 0.5 percent zinc; and single superphosphate with zero point zincated single superphosphate we can see here.

So, these are some of the fortified fertilizer which contain the micronutrient element.

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Now, let us see some fortified zinc and boron fertilizer. Now, regarding the subsidies on the value of these fertilizers, the government has clearly announced that any variant of the phosphorus and potassium fertilizer covered under the Nutrient Based Subsidy policy, if fortified or coated with boron and zinc as provided under FCO is eligible for subsidy. So, whatever phosphate or potassium fertilizer are subsidized by the government, if they are fortified or coated by boron or zing, they will also eligible for subsidy. Now, such fortified or coated fertilizer will attract an additional per tonne subsidy to encourage their application and primary nutrients.

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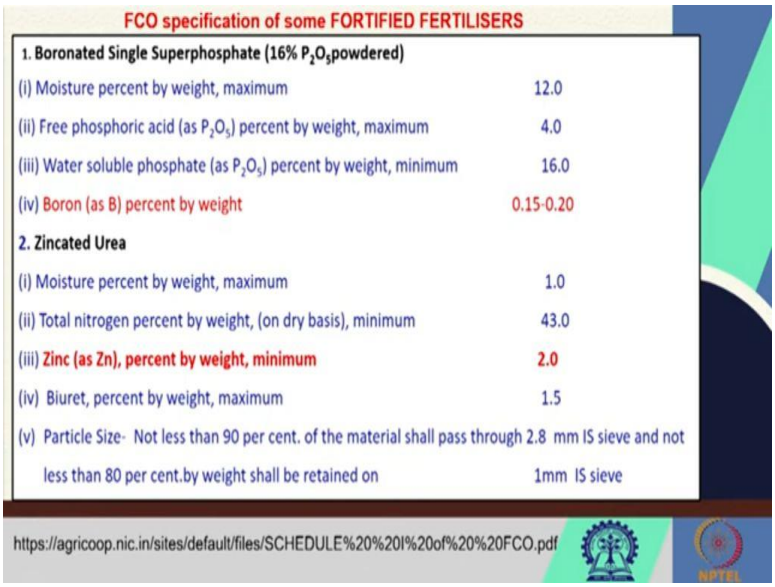

Now, let us see some FCO specification on some fortified fertilizer. So, first of all is boronated single superphosphate; you can see 16 percent P2O5 powdered. So, mixture percentage by weight maximum should be 12 percent. Free phosphoric acid as P2O5 percent by weight, maximum should be 4 percent. Water Soluble P2O5 as percent weight, minimum will be 16 percent. Boronate boron, percent by weight should be varying from 0.15 to 0.2 percent. Zincated urea moisture percentage by weight, maximum should be 1 percent. Total nitrogen percent by weight on dry basis, minimum should be 43 percent.

Zinc, percent by weight, minimum should be 2 percent. Biuret percent by weight, maximum will be 1.5 percent. Particle size- should be not less than 90 percent of the material shall pass through 2.8 millimeters sieve; and not less than 80 percent by weight shall be retained on 1 millimeter sieve. So, these are the specification by the FCO for this boronated SSP, which has 16 percent P2O5. And also we have, it has percent by weight 0.15, 0.2, 0.20 percent; and for zincated urea which contains zinc of 2 percent.

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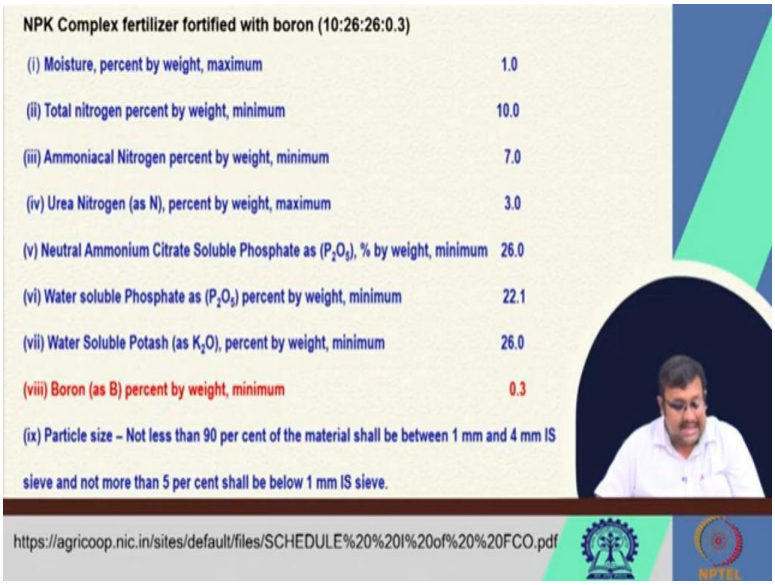

Now, also FCO specification for NPK complex fertilizer fortified with boron 10, 26, 26, 0.3; we can see maximum weight percentage of moisture should be 1 percentage, (maxim) minimum weight percentage of total nitrogen should be 10 percentage. Minimum weight percentage of ammonical nitrogen should be 7 percent; minimum, maximum percent by weight of urea nitrogen should be 3 percent. And minimum percent of weight of neutral ammonium citrate soluble P2O5 should be 26 percent; minimum percent by weight by water soluble phosphate should be 22 percent.

Minimum percent by weight of water soluble potash should be 26 percent; and minimum boron percentage by weight should be 0.3 percent. Particle size should be not less than 90 percent of the material shall be between 1 millimeter and 4 millimeter sieve; and not more than 5 percent shall be below 1 millimeter sieve.

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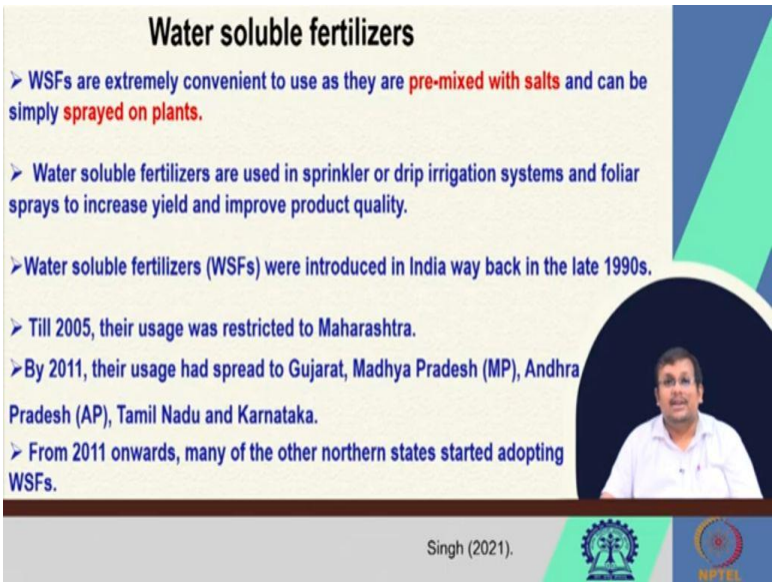

Now, let us discuss water soluble fertilizers. Water soluble fertilizers are extremely convenient to use as their pre-mixed with salts and can be simply sprayed on plants. Now, water soluble fertilizers are generally used in sprinkler or drip irrigation system and foliar sprays to increase the yield, and improve the product quality. So, generally we apply the foliar spray in the standing crop to increase their yield. Water soluble fertilizers are introduced in India way back in the late 1990s till 2005; their usage was restricted in Maharashtra. By 2011, their use usage has spread to Gujarat, Madhya Pradesh, Andhra Pradesh, Tamil Nadu, and Karnataka.

From 2011 onwards, many of the other northern states started adopting these water soluble fertilizers.

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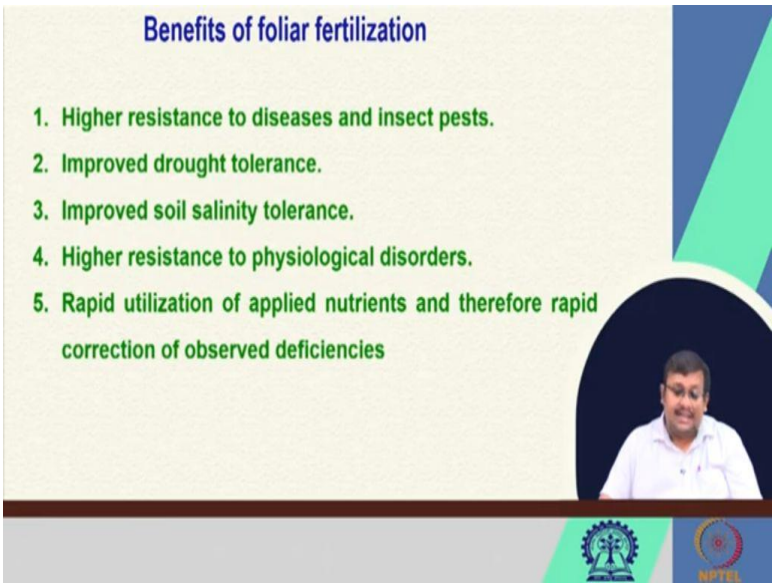

Now, what are the benefits of foliar application or foliar fertilization? There are five major benefits of foliar fertilization. Higher resistance to disease and pest; foliar application can help in improved improving the drought tolerance. It can also helps in improving the soil salinity tolerance. Foliar application can produce higher resistance to physiological disorders; and foliar application can help in rapid utilization of applied nutrients, and therefore rapid correction of observed deficiencies. So, these are the benefits of foliar application.

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Now, in India, water soluble fertilizer can be broadly classified into two categories. First of all, 100 percent water soluble complex fertilizers; and this includes grades like calcium nitrate, boronated calcium nitrate, mono ammonium phosphate; and then mono potassium

phosphate, and then potassium nitrate and urea phosphate. So, you can see mono ammonium phosphate has 12 61, 0; mono potassium phosphate at 0, 52, 34; potassium nitrate has 13, 0, 45; and urea phosphate has 17, 45, 44, 0. So, these are the grades. So, in India, we have 100 percent water soluble complex fertilizers; this is one category.

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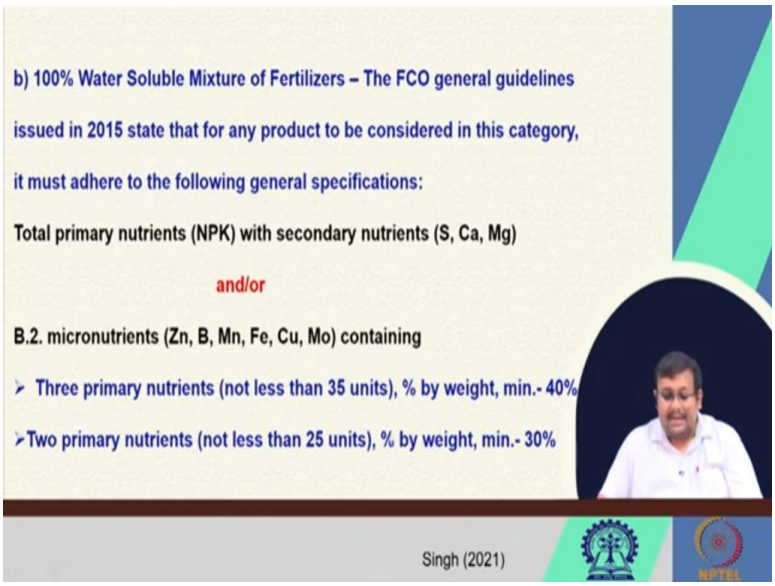

Another category is 100 percent water soluble mixture of fertilizers. So, the FCO general guidelines issued in 2015 state that for any product to be considered in this category, it must adhere to the following general specification. So, total primary nutrient with secondary nutrients, and or, so it must have total primary nutrients with secondary nutrient. What are these sulfur, calcium, magnesium and or some micronutrients like zinc, boron, molybdenum, iron, copper, zinc, boron, manganese, iron, copper molybdenum, which contains three primary nutrients which are not less than 35 units.

Percent by weight and minimum should be 40 percent. And two primary nutrient not less than 25 units; and percent by weight minimum should be 30 percent. So, these are the categories, these are the conditions of micronutrients for this 100 percent water soluble mixture of fertilizers.

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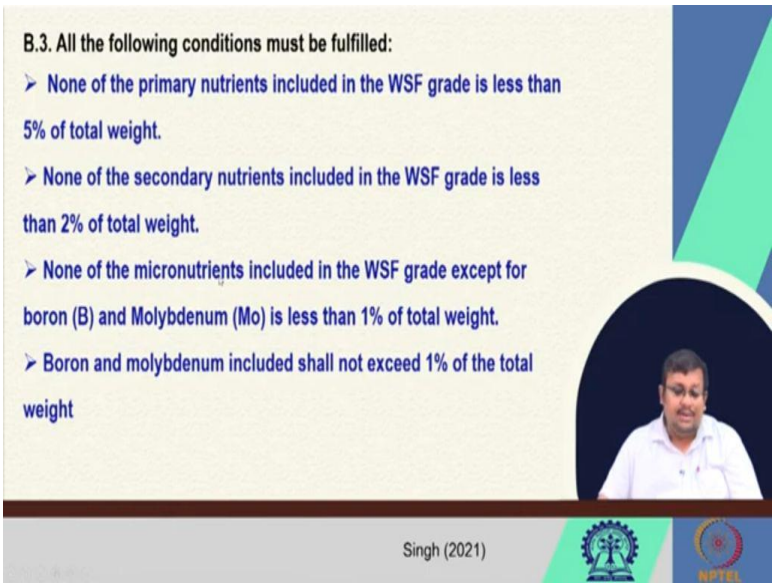

And another option is there, all the following condition must be fulfilled; this is third option. None of the primary nutrients included in the WSF grade is less than 5 percent of my total weight. None of the secondary nutrients included in the WSF grade is less than 2 percent of the total weight. None of the micronutrients included in the WSF grade except for boron, molybdenum in less than 1 percent of the total weight. And boron and molybdenum included shall not exceed 1 percent of the total weight. So, these are the other conditions which must be fulfilled for the third option.

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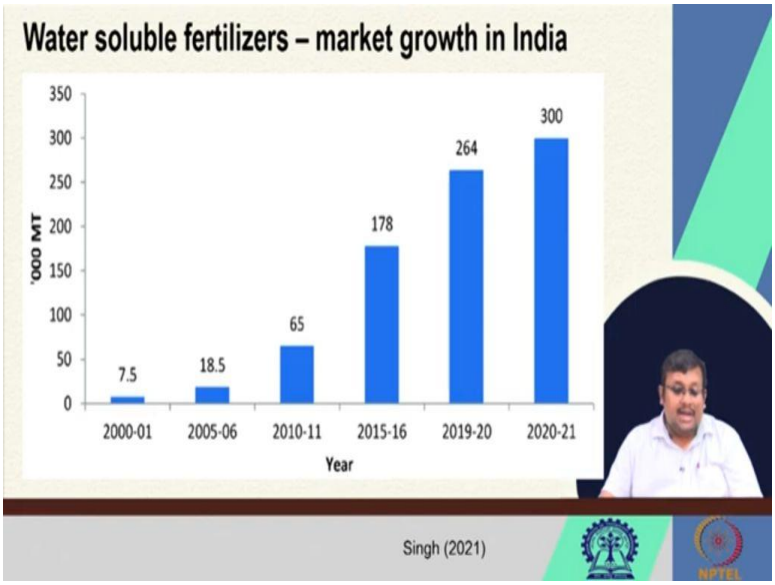

So, if we see the trend of water soluble fertilizer market growth in India from 2000 to 2020, we can see that the the market growth has increased tremendously from 7.5 thousand metric

tonne million, 7 point thousand million tonns to 300 thousand million tonns in India. And so, so that shows and very high increase in the market of water soluble fertilizers. So, guys in this this, in this lecture, we have covered some very important concepts. We have covered the plant growth promoters, we have covered fortified fertilizers; we have seen their benefits, we have seen some fortified fertilizers.

We have also seen the water soluble fertilizer, their categories, FCO specifications; and also we have seen biologically released micronutrients are biologically controlled release micronutrients we have seen. And all these are basically utilized, or in India for improving the fertilizer use efficiency, and fertilizer use efficiency; and also to improve the crop yield to correct instantaneously correcting the problems in the crop, five foliar application. So, these are some of the ways through which these type of fertilizers can help in in improving the soil fertility as well as the soil productivity.

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So, guys, we have wrapped up this lecture; these are some of the references of this lecture. And in the next lecture, we will be discussing about direct benefit transfer in the in the in case of in case of fertilizers. So, so far in this in this week that is week 9; for these three past lectures we have discussed the slow release fertilizers controlled release fertilizers. We have discussed these water soluble fertilizers and so on. So, please go through these fertilizers and there are plenty of references available in the in the website.

And you can you can consult these sources, so that you can enrich yourself with more information regarding the fertilizers. Fertilizers are very important for boosting the productivity, specifically in Indian condition where there is a continuous shrinkage of natural

resources or agricultural land, and continuous increase in population. So, we must select the best management practice as well as the best fertilizer combination; so, that we can reduce the cost of inputs. We can improve the soil fertility; we can enhance the soil productivity. So, let us wrap up here guys.

Let us meet in our next lecture to discuss more about how government of India has promulgated different policies; and what are the provisions they have made for better distribution of fertilizer subsidy for Indian farmers. Thank you very much; let us meet in our next lecture.