**Nanotechnology in Agriculture**
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**Lecture-24**
**Benefits of nanoparticles in Agriculture**

Welcome back to the course on nanomaterials in agriculture, so as of now we have talked about in detail about one of the nanomaterials iron pyrite and then we have enumerated the different kind of nanoparticles including silver, copper, manganese, calcium, magnesium, zinc, carbon nanotubes, iron oxide, iron sulphide hence one and so forth.

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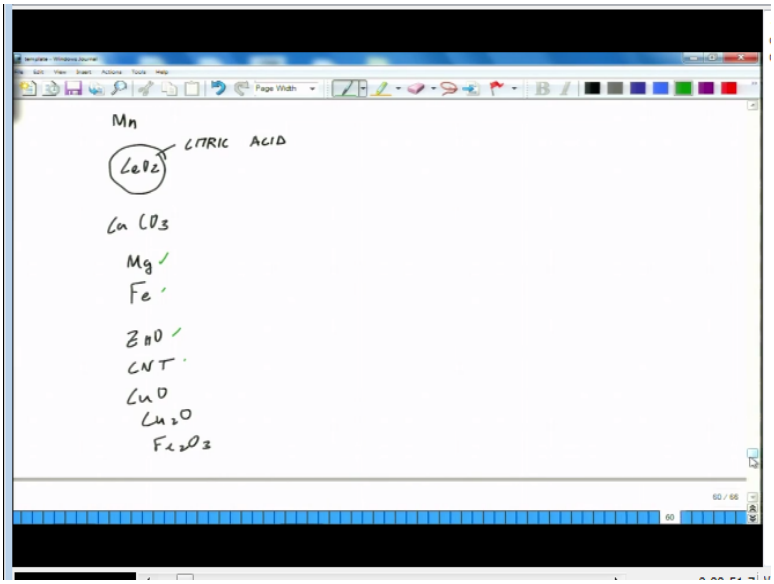


So, it is fairly clear that in years to come decades to come nanomaterial based agriculture systems or nanomaterials supported agriculture systems are emerging. And especially it will play a very critical role when we will be talking about the precision forming or precision agriculture.

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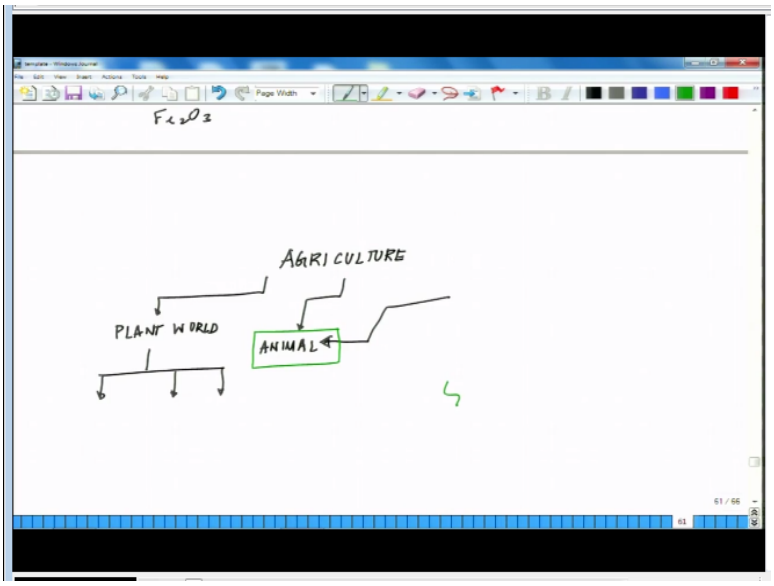


So, keeping this in light before we move on to the role of nanomaterials in animal world I wish to discuss some of the highlighting future of the nanomaterials in the plant world which will help as to appreciate how the nanomaterial based agriculture farming is going to shape up of our future. So let us look at some of the parameters are less unless some of the parameters of the benefits what we are obtaining from the nanomaterials.

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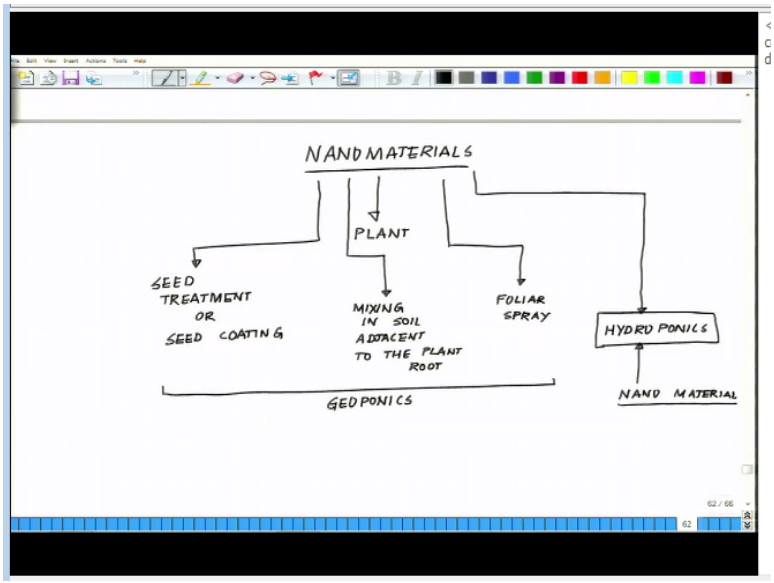


When there are applied to plants, so let us enumerate them we have nanomaterials in the form of particles, shades, colloidal suspensions. And here we have discussing the plant, so I will have discuss they there are different stages where they are being used either they are used as seed

treatment or seed coating is one aspect. The second aspect is mixing in soil adjacent to the plant root or there is foliar spray.

So these are the 3 modes by virtue of which nanomaterials could come in contact with the plant or when we talk about, so as long as we have talking about these are the geoponic mode where we are going the plants in the soil and if we follow the hydroponic modes when we are growing the plants in water or salt solutions. Then we are mixing the nanomaterial in the hydroponic itself. So nanomaterials becomes part of the salt solution which promotes the plant growth.

Now what are the benefits what we have absorb let us enumerate those are of now what we have absorb we have realize that it will leads to one better.

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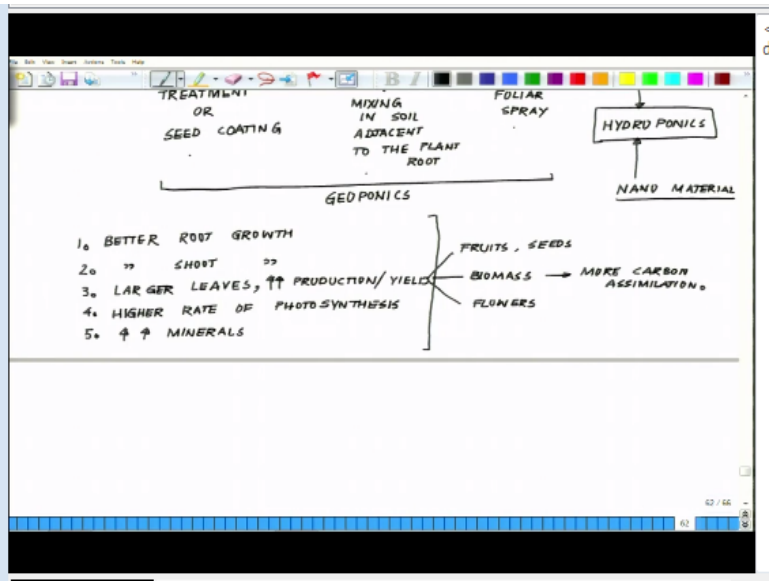


And I am not categorizing from which treatment it is coming whether it is coming from seed treatment, seed coating or by mixing into the soil or by foliar spray which over. But over all what we are observing is the better root growth, better shoot growth, larger leaves than higher rate of photosynthesis. And higher concentration of certain minerals not all but certain minerals now if you look at these parameters oh yes apart from it what we are absorbing larger leaves than higher production or yield in terms of roots, seeds as we have absorbed as well as in terms of flowers okay.

And apart from it what we have absorbed is hired dry biomass so, in another word more carbon assimilation. So this is the overall summary if I have to put it across on both like the nanomaterials in the plant world, in one frame we have to look at this picture. So, this is something like this what has happened, in a single frame if I have to summarize, so this is the summary sheet which will tell. These are the effects or these are the benefits what we are obtaining by the nanomaterials.

And in some of these cases what we have absorbed is nanomaterials are helping at very low concentration are helping in reducing NPK requirements.

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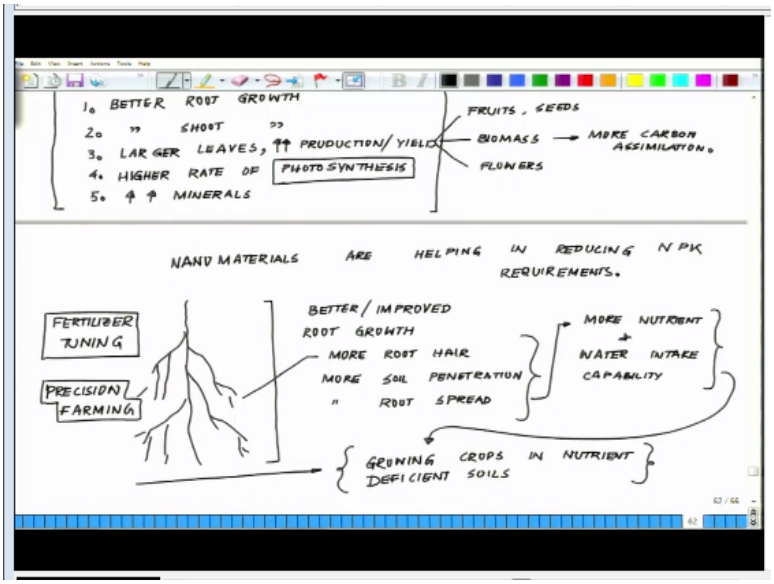


So this is extremely important for us to understand that reduction in the NPK level will eventually help us to mitigate the problem of extreme amount of leaching which happens in the soil into the water bodies of nitrogen, phosphorous and potassium all other different elements or component of fertilizer which we are putting in excess into the soil. Now if we look at rationally try to figure out what is happening.

If we see that this leads to a better say root growth something like this okay, say for example this is the representative root I am drawing. So what we are absorbing is the higher root here whenever we talk about better or improved like the right word will be improved root growth. So

we are essentially talking about more root hair, more soil penetration, more root spreads. Now all these 3 things will lead or will help this plants to acquire more nutrient.

Because we have a more spread okay, so this will lead to more nutrient and water intake capability, so this that means these kind of treatment could be an answer for growing crops in nutrient deficient soils okay. When we talk about nutrient deficient soil we are talking about large part of African continent, Latin American continent, Asian continent, South east Asia huge huge area of land marks which are nutritionally so called again.

This is a very relative parameters when you talk about so called they cannot match the requirements of many of the green vegetables and pulses, crops which has been set currently by food and agriculture organizations and other organization or fertilizer organizations. So here is an opportunity where nano particle treatment, if it is done in a benign manner. If it is benign like iron sulphur something like you know, little bit of silver. little bit of copper as long as we are not hitting any kind of a toxicity zone.

Carbon is a matter of fact which we have been eating since time memorial if you look at carbon like you know we eat the roasted meat, Barbequed meat, barbequed fish. These are all nothing but carbon and known in other these are all carbonaceous materials. So much of these carbons are already part of our food chain. So and they are people who always argue about t what is the toxicity of this carbon kind of material.

But hey if you look at we roast vegetables if we really take out that blackening part and if you analyze it you see they are nothing but different forms of carbon in the form of ant thin sheets graphene like sheets, some kind of a tubes like and so for, we have been using kajal you know many of you use that black stuff under in the eyes for an improved eyes the better eyes, there is nothing but a carbon.

So, as a metaphase carbon is part of our lifestyle I think for centuries for million year, so why we make so much high power it oh this will cost (()) (13:38) and all of these kind of stuff probably not of course as long as we are maintaining a threshold how much to use. So, this is one aspect

what I am wanted to highlight here growing crops in nutrient deficient soil may be nano is that precision. You can really apply the required amount and this could be another answer for fertilizer tuning.

You can tune the fertilizer requirements for such soils okay, similarly you can use fertilizer in precision farming where you really have to be very particular. So there are different areas where the soul nanomaterial will come very handy. Now the same line if you talk about then we are talking about another aspect we are absorbing that the leads of higher rate of photosynthesis. This is extremely important another aspect if you look at it think of it rationally.

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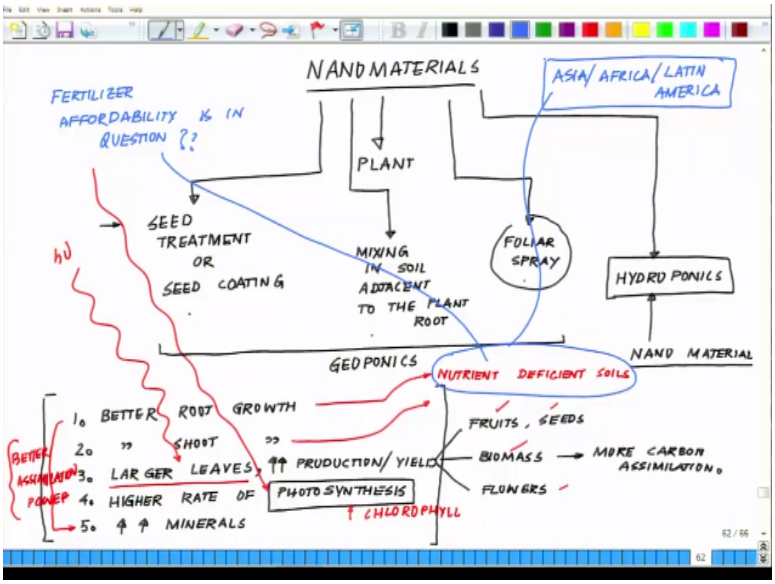


When we talk about photosynthesis what we are talking about is, so you are major source of energy on this planet which is sun okay. And here you have a plant which has been treated with some kind of a nanomaterial whether at the stage of seed or root or foliar spray whatever okay Now higher rate of photosynthesis means rate of photosynthesis. This essentially means we are increasing the area of trapping the light.

So in other word it means these plants will have higher level of chlorophyll which has already been documented okay high level of chlorophyll. This higher level of chlorophyll means you will have a high level of photosynthesis, so then in a finite area of a plant growth you are increasing

the energy harvesting potential of the plant which is converting energy harvesting potential of the plant where you are essentially converting carbon into carbohydrate.

So a plant which is getting from its root system more minerals and water by virtue of its improved root architecture and vary plant having a better solar energy harvesting potential will eventually will lead to a better and improved yield in terms of fruiting, flowering, foliage okay. So if you remember when I told you what are the snapshots I wanted to discuss with you let come back to the snapshot again.

So here we are having a nanomaterial whether it is in the seed treatment level, seed coating level mixing the soil in a trace amount or it is a foliar spray or even if it is in hydroponics. We are seeing better root growth, so that these help for nutrient deficient soils, shoot growths larger leaves. So that means higher solar harvesting capability a better solar cell and actual solar cell that means also.

And of course higher rate of photosynthesis here the next one which means higher chlorophyll and then mineral content. Because this is the better route and better assimilation power and what we are essentially seeing after that is that if were fruit production, seed production, higher biomass and better flowering**.** So this is what I wanted to highlight that nano is possibly the answer for those places where fertilizer affordability is the question.

Fertilizer affordability is in question nano could come as one of the most portent tool to counter the problem of and mostly this fertilizer availability is directly linked to nutrient efficient soils of Asia, Africa, Latin America name of few okay. So in other words these are small results there is some pieces because a whole field is growing, next to be watched out very carefully with open mind, with a positive frame of mind without getting broke down by you know.

There will be always opposition is telling none this is toxic and that is toxic and also things will happen. But with open soul, with open mind if you look at it you review yours, we realize that we have to increase a production because there is no other way. And we have to be judicious, we have to be sustainable, we have to precise. These results slowly needed to be translated into the

field to the slower down process but with the positive frame we as a race can make a difference of going to the next revolution which is we are assuring into history of the written like that.

That we as a race emerge into the word of nano which judiciously if you look at it and crack fully if you play the game we can meet the challenge faced by mankind that timid millions with their hungry source. I think that is where much of our answer lays using nanomaterials in a very judicious manner, thank you.