Nanotechnology in Agriculture
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Lecture-17
Nanomaterials in Agriculture

Welcome back to the course in nanomaterials in agriculture, so as of now I have talked you about the different kind of nanomaterials, the morphology, the structure followed by the synthesis techniques and then the characterization. And earlier to that we have talked about the overall situation why there is a need or there is a extreme interest about using nanomaterials in agricultural products.

So now we were shift gear and we will move to the practical application of nanomaterials in agriculture.

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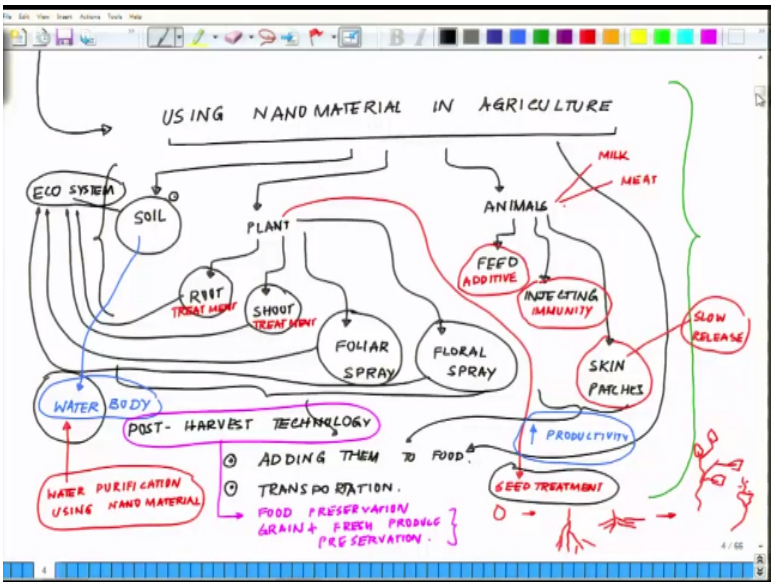

So, if you recollect the one of the slides which I talked pretty early when I started the course is using nanomaterials in agriculture and there we talked about where all nanomaterials could be used where it could be used into the soil directly or it could be used in the plant body. And at different stages of the plant growth or it could be used into animal feed or injecting the animals or for skin patches.

Now when we talk about putting a nanomaterial into the soil we are essentially talking about the resources like water, soil will be under the influence of nanomaterial. So that is something which we have to realize or appreciate or understand that exactly what happen in fertilizer should not get repeated. So to ensure that the nanomaterials what we are using or benign to consumption if at all the residues remain or gets degraded over period of time okay.

So whenever we talk about the soil we are directly talking about the water bodies and that is where some of the purification things nanomaterial to purify water that is what will be discussing under this topic okay where there is a lot of research going on water purification using nanomaterial okay**.** Now talking about direct applications into agriculture either it could be used to different parts of the plant body.

Either for the root treatment or shoot treatment or foliar spray or floral spray as well as something which I have mention earlier is seed treatment. So starting from the seed which is like the dormant part of the growth to the root treatment or root priming depending on what kind of routes we are talking about all the way to treating the shoot as well as the foliar spray all the way to the flowers.

Now in the case of animal especially it is use for animal productivity in terms of either milk production or meat production it could be used as a feed additive. We talk one such example where there is a hope with 1 of the nanoparticle or they could be injecting for immunity or they could be used as a skin patches for slow release. The overall goal of these kind of application is enhancing productivity both plant and the animal world.

Apart from it there is tremendous thrust of applying nanomaterial for post-harvest technology which includes food preservation mostly this includes grain and fresh produced preservation which includes of course cut flower preservation and all the kind of other off shoot areas into the field. So to start off with I will start off with seed treatment agent as nanomaterials.

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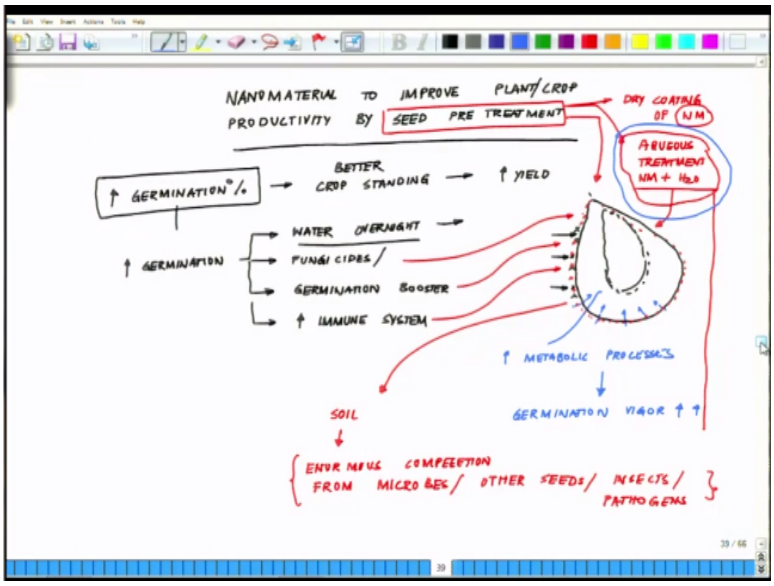

So nanomaterial to improve plant/crop productivity by seed pretreatment. So to start the topic seed pretreatment in other word farmers before showing the plant or before showing the seeds, they do treat the seeds. They treat the seeds in different ways, they can either use different kind of fungicides, they can use different kind of a germinating agent which will promote faster germination or they can be use some other kind of growth booster to ensure the seed germinates.

So as a matter of fact the success of any crop depends on the germination percentage higher the germination the better the crop standing and on all like we have the all other parameters may incurred than higher will be better crop standing better higher the yield. So, this critical part is extremely important than formers have been using to enhance germination, they treat the seeds with different kind of thing.

The major treatment they do possibly is the water treatment or overnight treatment in water apart from they use different kind of fungicides, germination booster or any other kind of you know agent which will help it to strengthen its immune system okay, strengthening immune system. Now for the simplest of all the things water treatment what the water does. So if you look at the seed it is something like any series like this.

The seed coat and inside is the real growing material is preserved inside okay. Now the seed coat is mostly impermeable to water, it does not allow water or any other things to pass through so

easily. So, when it gets an overnight treatment with water slowly the water molecules kind of enters inside period of time and activate the metabolic processes. So the next morning so this is metabolic processes, so the next day the germination vigor is more.

So, this is an agual practice what farmers have been following through centuries since possibly dawn of civilization and it will continue till the dusk of civilization. These are very very common methods similarly farmers use some kind of a coating of stuff, so this red is ideal coding or some kind of germination booster or some kind of immune molecule which ensures once the plant gets into the soil.

So, once the plant is into the soil there is enormous competition from microbes who are compete in for food from other seeds of the same family as well as from the other families and from different insects and other pathogens. So a life of seed soon after it gets into the soil is really treasures one, it really tough because the life has to express itself and that is very challenging.

As a matter of fact in that competition to germinate the one which will win is the one which will make a mark, the one which will fail to germinate will lose this battle okay. So now keeping this in mind one of the most easiest approach of applying nanomaterial could be seed pretreatment agent. So once you are applying in to the seed, so whatever you are trying to do has to be the overnight stuff and ensuring that these seed pretreatment agent are doing something after coming in contact in that millue.

So, whenever we are treating, so there could be 2 kind of treatments you do either it could be a dry coating of nanomaterial on top of the seed dry coating of NM stand for nanomaterials okay or there is some kind of an aqueous treatment. Aqueous treatment is basically nanomaterial+water that is how you are treating okay. Now today I will be sharing one of the stories of this second treatment aqueous treatment when nanomaterial+water and where it acts.

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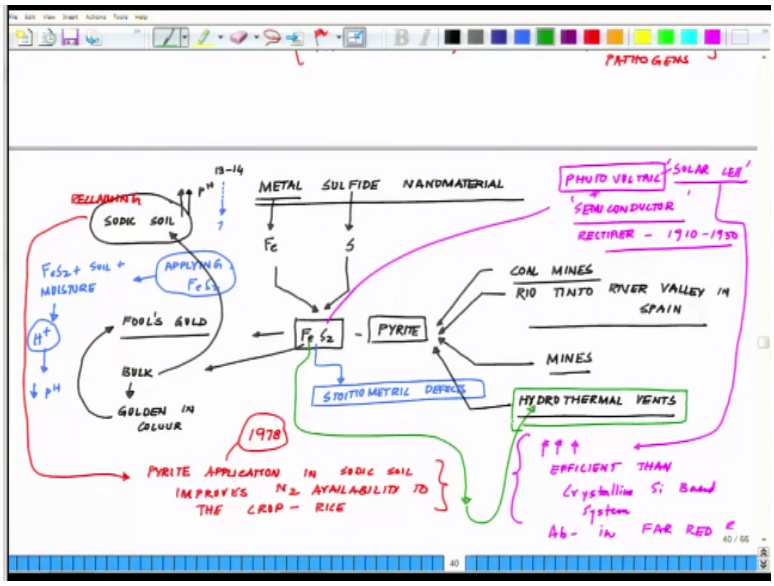

So, our first journey will be with one of the metal sulfide nanomaterial and this is possibly one of the very very first nanomaterial base seed treatment agent which I have shown profound impact on at least 10 or 12 different crops by increasing the productivity to the level it has ability to compete with the fertilizer applications. So the metal sulfides here the metal iron, sulfide is S, so compound what whose nanomaterial we were dealing with will be FeS2 which is also called pyrite or crushed is rich very rich in pyrite.

There is huge amount of pyrite all over the crush especially if you go to the places like close to the coal mines or you visit places like where you really see a huge amount of it is rio, tinto river valley in Spain or there is another place where there is a rich source of pyrite apart from the pyrite mines. There are lot of pyrite mines all over you will see huge amount of pyrites in deep inside the earth into the hydrothermal vents.

As a matter of fact pyrite is also called as fool's gold, the reason it is colloquially called as fool's gold because the bulk pyrite is golden in color. And that is why many a times people mistake it as a gold that is why it is called as fool's gold okay. So pyrite is a very interesting compound which has find applications in myriad or places like in terms of agriculture bulk iron pyrite is being used in sodic soils, reclaiming sodic soils.

Say for example a soil which is sodic or pretty high pH like say you know 13, 14 or something we can bring down the pH by to 7 which is a physiological pH by applying FeS2 or pyrite. Because once FeS2 gets into the soil in the presence of moisture it generate sufficient amount of protons which brings the pH okay. So for reclaiming sodic soils pyrite has been used especially in Indian context if you talk about.

And such reclaim sodic soil has shown pyrite application into the soil in sodic soil improves nitrogen availability to the crop. Especially this has been observed in the rice crop but a challenge of using pyrite is pyrite brings down the pH. So, a normal soil can become acidic or will become acidic or has destined to become acidic if you use bulk pyrite into the soil, so keep that in mind.

And there are certain trials which are done in Kanpur back in 1970's, so this is what I am talking about is around 1978 okay. So, almost 40 years back, these kind of research happen in India but there was nothing called nano or anything. Apart from it pyrite is one of the very extensively study material in of photo volatile and semi conductor. For semiconductors application these were used as rectifiers as early as 1910 to 1930.

This time when these pyrites where used as rectifiers and it has tremendous photo voltaic potential if it could be exploited for the solar cell applications. So, pyrite is nothing new to us, pyrite is a fairly old molecule through the ages and as a matter of it is being claimed that if pyrite could be used as a solar cell material. It will be far more efficient than crystalline silicon based system because it has a tendency to absorb in far red region okay.

So this is one of the key reasons why there is tremendous amount of interest in nano iron pyrite starting from electronics to photo voltaic all the way to reclaiming sodic soil. It is found tremendous application but it comes with a small drawback, it suffers from something called stoichiometric defects. So, we will continue with what is the meaning of stoichiometric defect and from here we will go down all the way to the deep deep into the dark world called hydrothermal vents.

Because from here started our journey of it is application a new application of brand new application of nano pyrite which was never discovered earlier the first time it is discovered in India was as a seed treatment agent, thank you.