**Micro Irrigation Engineering**
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**Lecture - 28**
**Fertigation**

Hello participants, I invite you to lecture 28. It is on fertigation. We discussed in micro irrigation components parts. So we gave in the components, the head control unit, the water is supplied from the source with the help of pump and then depending on the quality of water it will pass through the filter. It will pass through maybe if the water it has got a lot of silt then water may be stored in the desilting basin. Then we will have a fertigation unit followed by a set of filters and it will come to the main pipeline, sub-main pipeline, the drippers, etc. So here one of the important components in a micro irrigation system is fertigation.

So in this lecture, we will be discussing about the importance of fertigation, how the fertigation development has come over time. So this deals with the fertigation history. What are the advantages and limitations of fertigation and what are the major types of fertilizers which can be supplied using micro irrigation system or through the micro irrigation system.

If we look at precisely on the definition part, so fertigation is the precise application of plant nutrients with an irrigation system in the crop root zone according to the crop requirement during the growing season of the crop. We are giving fertilizers, in fact, all chemicals which are required for the plant that can be injected with the system. So fertigation, chemigation can be also done by using a micro irrigation system.

Chemical means practically when we are giving water this is a chemical fertilizers, which are dissolved in the irrigation system. When the water is being given with the help of a drip emitter what you see it forms a wetting bulb. Now when water along with the fertilizer both are means the plant root received the water and fertilizer, so it is within the root zone system.

So this is the way the how the water is moving, the way waterfront is moving, the fertilizer will also move at the same time and in the same location.

So in fertigation, fertilizer application is made in a small quantity. This is the beauty that means as the water is given in a small quantity fertilizer is also given and in frequent doses. So the plant water requirement, food requirement when it is at the early stage, it is less in the quantity. So this should be also fed in the same way.

So frequent dose that is fed within the schedule irrigation interval matching the plant water used to avoid leaching because water is given in a precise quantity. So it does not go beyond the root zone depth. So leaching is avoided. The right combination of water and nutrient is the key for high yield and quality of produce. In order to achieve greater crop production, it is required to supplement nutrients by adding chemical fertilizers and nutrients.

Over the years it has been found that to get the goals of agronomic and aesthetic lushness we need to provide water with fertilizer together. So fertigation allows selection of nutrient input as it is needed wherever it fits the prescription means yes it is like we are giving, the human health we are giving a prescription. Here also there is a prescriptive dose what should be the amount of.

So it should be given as the prescription and what should be given in the initial stage in the development stage in the maturity stage like this. So in the same way the amount of fertilizer it should be given as per the prescription, time of the year as well as saving in operating money. When we are giving in so there is nothing like any over fertigation, over-fertilization, or under-fertilization.

So we save the money, we save the energy requirement which is aided for giving fertilizer as well as water. It is a safer application method and it eliminates the danger of affecting roots due to higher doses. This is a common problem when we are using the conventional method of water as well as fertilizer application.

Now if we look at the literature and from the literature, we find that fertilization of gardens was done, as early as 400 BC and then the first liquid fertilizer patent was made in 1899 in the US. In 1942, anhydrous ammonia was given as an injection dose.

And then what we find that in 1953, the first liquid fertilizer plant was established for ammonia, application of ammonia, phosphoric acid, and potash in the USA, as well as the first reported application of commercial fertilizer through the sprinkler irrigation system, was done in 1958. So like this, we see the historical development. Then in 1974, the US had 2800 number of fluid fertilizers plants.

The ammonium nitrogen solutions which are 32% of US fertilizers these were given in the liquid form. Then fertigation with the liquid fertilizer in grapes and bananas started in 1993 and then slowly it has been realized that fertigation means giving water along with the fertilizer, it is giving better results in horticulture crops. So Israel started doing it from 1994 onwards.

Now in the conventional method of irrigation means we are just broadcasting the fertilizer in the solid form. So the plant gets a higher dose than it requires number one, and then the weed growth, because the water, as well as fertilizer when it is coming so weed, is also a problem that competes with the plant.

When we are giving the fertilizer along with the water through a drip irrigation system, so what we find the uptake rate of the plant enhances and that is giving the better response.

So here what happens if the fertilizers are applied separately from water? This means that is the common practice when we are giving conventional irrigation. When you are giving separate, one cannot get really good results. So when pressurized irrigation systems are used, fertigation is not optional but it is absolutely necessary.

In drip irrigation, when we are giving water particularly in horticultural crops, we know that we are irrigating to 30% of the root zone area. So only 30% of the soil is wetted by drippers. So fertilizer will remain here only in the wet portion. So the full benefit of the fertilizer will not be made available to the plant.

So fertilization efficiency decreases because the nutrients will not be dissolved in the dry zone area where the soil is not wetted. So full benefit of using drip irrigation will not be achieved. So fertigation is absolutely necessary to the crops when we are giving water with the help of drip system the fertigation is an important component.

Now here is this particular picture you can see if we are giving water with the help of conventional irrigation system the water as well as fertilizer when it is being given you find that the water and fertilizer are percolated fast it is not available. So this is the way the rooting system develops. So when the water, as well as fertilizer, is given with the drip irrigation system you can see the density of the rooting system.

So it develops optimal moisture as well as aeration condition. The compact root zone saves the plant's energy. So better intake of nutrition takes place when irrigation is given with the help of a drip system.

Now in the case of drip system, the limited root zone with drip irrigation system. So nutrient reservoir is 30% of the total area. This is what we see that how the wetting bulb forms. So creating a limited supply of organic matter and mineralization products. So higher depletion rate in the weighted zone because the nutrient uptake is fast because of the frequent supply of nutrients is needed.

Now frequent irrigation intervals avoid leaching and the loss of nutrients. This is happening in the case of drip irrigation. Whereas the broadcasting method of the fertilizer application that is the solid fertilizers, it is inefficient, it does not give the fertilizer to the plant. Rather when the water is being given through the flood irrigation and then broadcasted so what will happen it will form runoff and then through the runoff process the fertilizer will be going along with the overland flow or it will go beneath the root zone depth.

So these are some of the advantages which are listed when we are giving the fertilizer along with the irrigation water. So drip irrigation there is less compaction, when we are giving fertilizer there is a reduced energy requirement, the reduced labor input, you do not have to use labor for giving and then even distribution of nutrients also it

takes place, and application of nutrients it matched as per the timing for which the plant requires it can be given. There are disadvantages when drip irrigation system when we are supplying fertilizer. So what happens, the drippers are sensitive to clogging because drippers are having a small orifice size.

So outlet size is small and then when we are using fertilizer there is a chance of the precipitation of certain chemicals in the water so there is a chance of clogging. So one has to take care of those chemicals which have got limited precipitation problem. It may require expert design. Yes, this is needed because if the fertigation system whether is fully operational. So this needs some knowledge initially but over the year when the skill is developed by the farmer by the constant use, this is not a serious thing it can be taken care of with time. Potential contamination hazards from the equipment and malfunction.

There is a chance that if the backflow preventing device is not installed and it may likely that it may start contaminating the source of water. So backflow prevention device is a must. Not all the parts may be available locally. Now in India this used to be the problem earlier but slowly the benefits of the fertigation system, benefits of the micro irrigation system are realized.

So that problem you know that there are quite a good number of companies, as well as dealers, are available at the block level now things are coming. So this is not a serious issue for implementing a micro irrigation system.

There are some certain characteristics which are needed for a fertilizer that should mean high nutrient content in the solution. It should be fully soluble at field temperature. It should be fine grade and flowable. This means it should not form the deposition in the water or in the container. No clogging of filters and emitters. This is a requirement for fertigation when we are using certain fertilizer and when we are using. So it should have no clogging filters. Low content of insoluble material and then minimum content of conditioning agent. It should be compatible with the other fertilizers. So one should know the chemistry of these fertilizers. This is an important aspect one should learn.

And minimum interaction with irrigation water and no drastic change of the pH means the value of chemical which is added with the water. So it is ranging from 3.5 to 9. So that should be also seen. And then after you are adding, it should not means the fertilizer should not be highly corrosive so that should not affect the control head units or components.

Normally we are using nitrogenous fertilizer, potassic fertilizer, and phosphatic fertilizers. So nitrogenous fertilizer when we are applying, what are the nitrogenous fertilizers? These are ammonium sulfate and then you should know that what the nitrogen content in this type of fertilizer is. So urea has got highest nitrogen content. It is 46% and it has got a solubility of 1100 gram per liter.

When you are using ammonium nitrate it is nitrogen content is 34% and then the solubility is 1920. So this is highly soluble. And then calcium nitrate is another compound that can be used. So most of the commercially available nitrogen fertilizers are readily soluble in water and they do not have any problem with fertigation. So they can be very easily used for fertigation.

Phosphoric fertilizers could be di-calcium phosphate. It has got high phosphorus content of 52% but the problem is solubility. So this is the one problem. Mono-potassium phosphate, it is 52%, solubility is the problem. This is only 340 grams per liter of water it needs to means make it dissolved.

Mono-ammonium phosphate, it is 48% so as you see that phosphoric fertilizers, these fertilizers are having a problem. So this is to be taken care of as far as this you need to have enough water to dissolve in the water.

The potassic fertilizers could be potassium sulfate. You can see 50% K and then solubility is also the same type of thing that 110 gram in one liter. Like this, you can see here how the solubility of the potassium chloride, potassium nitrate, is 44%. And this is a commonly used fertilizer to meet the requirement of nitrate as well as potassium. Potassium sulfate is another so potassic fertilizers are also best suited for fertigation.

These are micronutrients which are commonly used for meeting the requirement of the plant and depending on the particular kind of a particularly let me just tell you in the lateritic soil there is zinc deficiency in the soil, manganese deficiency. So one has to know that what are the deficiencies and then what should be the amount of fertilizer should be added depending on knowing their nutrient concentration. And then how much amount of water, it should be added to get the adequate solubility.

This is a very important chart which is required, this particular chart says about the compatibility of different water-soluble fertilizers. So you see here urea, ammonium nitrate, ammonium sulfate, calcium nitrate, mono-ammonium phosphate, mono-potassium phosphate, and potassium nitrate.

Now when you are seeing the urea, so when urea is mixing with the ammonium nitrate this is compatible, you can see here urea is compatible with all types of these fertilizers. Then ammonium nitrate is compatible with all kinds of these fertilizers/chemicals. So then ammonium sulfate, this is also compatible except calcium nitrate it is low compatible.

Calcium nitrate one cannot mix with the mono-ammonium phosphate because this is not compatible. So whether it is a mono-ammonium phosphate or whether mono-potassium phosphate, this is not compatible, one should not mix these two fertilizers. So here NC refers to the non-compatible fertilizers. So one should take care when we are making these types of fertilizers when we are using.

The fertilizers evaluation for suitability to irrigation. So these are the parameters, which are to be taken care of, and based on how they are suitable for irrigation. So one is your solubility. It is always a question mark that how good soluble it is in water. The second thing is precipitation. Does it form precipitation? So this is another point, how compatible a particular fertilizer is with other fertilizers?

Whether it has got acidic property, whether does it form corrosion? So these kinds of things are important. So you can see here ammonium nitrate NH4NO3, it is highly suitable, it has got low precipitation, it has got good compatibility with other fertilizer, it is a medium from the relative point of view it is with the compatibility is concerned.

Similarly, you can see here about this is your (NH4)2 SO4 that is ammonium sulfate is another compound. This is medium soluble, but it has a problem of high precipitation and poorly compatible, poor corrosion. So these things are important when we are considering a particular type of fertilizer.

Let us say this is one fertilizer, potassium nitrate, which is commonly used. This is a medium, it has got medium solubility. It has got low precipitation. It is medium compatibility and as far as it is good to the corrosive property means, it has got less corrosion from potassium nitrate is considered a good. The same thing is your H3PO4 that is the phosphoric acid. It is a good fertilizer which is used. This is your mono-ammonium phosphate.

So these type of fertilizers they are used, but this has to be understood properly and then the system is to be flushed immediately after the use so that it does not remain, fertilizer does not remain in the system and it will have lesser effect as far as the corrosion is concerned, as far as the precipitation is concerned.

There are some fertigation safety devices. It is an important device. It is not only simply for fertigation but even for when we are using the irrigation system. So there is a chance of getting air locking and so an atmospheric vacuum breaker is required when we are using these in the system. And there is a check valve you are seeing this is the one. We are coming with the different types of valves.

So one of the valves is a check valve. So water can go in this direction, you are seeing here the water can go. But the reverse entry of water is not done. This is the double-check valve assembly. You can see here how the water is entering. Entry takes place, there is a set of the valve. There are check valves. So, setting the supply as well as checking the amount of water which is flowing is done.

So this is another device which is used. This is another kind of double check valve which is provided in the system. So these kinds of systems or valves are used when we are using fertigation devices.

One should use some of the precautions. These are very important because we are introducing chemicals with the system and we have got certain advantages when we are using a fertigation system. But one should use it carefully and follow the precautions which are important for doing a successful fertigation system.

So operating pressure variations should be minimum in order to achieve uniform mixing of nutrients and irrigation water in the drip system. The other part is the compatibility of the two fertilizers. Already I have given you in the table that when we are using two fertilizers one should see there is a minimum or there should not be any precipitation that may cause a problem of clogging of drip emitters and filter system.

Then to eliminate the entry of solid particles or dissolved particles of the fertilizer, a small screen strainer is used at the end of the suction line so as to prevent the entry. Now adjustment of the water pH should be made from time to time. This should be checked frequently. This is always needed and particularly when we are calling of hydroponic system.

In a hydroponic system, the adjusting the chemical dose where we need to know that what is the pH of the solution. So at that time, the fertigation unit is a very important unit that should be used.

Pesticide and chlorine should not be injected in combination with the fertilizer system. Chlorine is normally used to prevent the clogging part or cleaning of the system. So this should not be used when we are giving fertilizer solutions. This means when we are giving fertigation, this should be done after the fertigation is done.

To remove the undissolved particles and precipitates the fertilizer injection point must be at the upstream end of the filter system so that adequate filtration can be done. Irrigation and fertilizer injection pumps should be compatible to prevent the entry of fertilizer into the irrigation line. The control for motors of both the pumps should be electronically interlocked.

Check valves should be installed in the fertigation injection line to prevent the backflow of water from the irrigation system so that it does not contaminate the source of water. That is your irrigation means water because this irrigation water may be used for drinking by cattle or livestock.

The check and vacuum relief valves should be installed to prevent the water or mixture of water and fertilizer from draining or siphoning back into the water source. So this is, of course, I am just certain point these are being repeated which I have been telling here.

So we covered all these things and then for more details please refer to these books as well as these you know internet material which will give you more insight about the fertigation system as well as fertilizers.

So let us summarize this particular lecture. We discussed about the concept and then the how the history of fertigation, it is started and then what are the importance of fertigation, what are the advantages and disadvantages of fertigation system, and then the different types of fertilizers, the nitrogenous fertilizers, potassic fertilizers, as well as phosphoric fertilizers and their characteristics, nutrients, safety precautions, all these things we discussed.

And now in the forthcoming lecture, these fertilizers whatever I have discussed, how it can be injected by a different method, so we will be discussing in forthcoming lecture. So thank you very much for your patience hearing.