

Micro Irrigation Engineering
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Lecture – 22
Micro Irrigation

Hello participants, now, we are entering lecture 22 of micro irrigation engineering subject. In lecture 22, we will be dealing with micro irrigation and this is just what we are entering in the subject title micro irrigation engineering. So far, we discussed basic fundamentals of the subject, related to micro irrigation engineering where we discussed about flow through pipes means using principles of fluid mechanics. We discussed about the soil-plant-water relationship. We discussed about different soil water potentials. We discussed about irrigation scheduling and then surface irrigation methods. So, let us get into the topic of today's lecture, which is on micro irrigation engineering.

So, here we will deal with what are the benefits? What are the importance of micro irrigation engineering? When it was introduced historical background? And in micro irrigation, what are the different system components that are used? And what are the different types of micro irrigation?

Now, when we say micro irrigation, it is one of the types of pressurized irrigation. A pressurized irrigation system is a system consisting of a network of pipes, their fittings, and other devices through which water is supplied by using external pressure. The water is brought from the source to irrigate the area. Now, the basic difference between conventional surface irrigation and piped irrigation techniques, here, let us try to learn from the water flow regime; how the water is moving.

So, when we say water flow regime, how does the water takes place. It means here water is applied in the network of the pipeline where the pressure is created whereas, in surface irrigation, it is overland flow. The overland flow means, it is the inertial force, gravitational force, and then water which is released from the reservoir, in a canal, it comes from certain pressures so the gradient is causing the water flow to take place.

Root direction of the flow, the root direction of the flow in the traditional method, is simply a slope that guides the water to flow. In pipe flow, it will depend upon how much pressure it is being created. Irrespective of pressure, irrespective of the direction of the flow or direction of the slope, the water will move into the pipe that how much pressure it is being created in the pipeline.

And then area irrigated, area irrigated in the pipe flow if there are several openings in the pipeline, so, the whole area can be irrigated simultaneously in case of pipe irrigation whereas, in the surface irrigation system, the whole area at a time it cannot be irrigated. So, this is the difference. This point is where I am talking about the external energy required in the case of pipe irrigation. It is correct. We need to provide adequate pressure in the pipeline, so, as to deliver water at each and every point of the field, whether it is a very highly elevated point in the field or it is in a very low elevated point. When we talk of the pressurized irrigation system so, this pressure which is being created by using a pump, so, it can be put up that how much pressure it is being created with the help of the pump.

So, is it a low-pressure system or we are putting it using a simply overhead tank? So, it is a low-pressure system. So, low pressure is categorized by using means up to the pressure of 3.5 bars. When we say pressure, it ranges between 3.5 to 5 bar, it is a medium pressure system and when the pressure requirement or pressure created is more than 5 bar, it is a high-pressure system.

So, when we talk of micro irrigation system, micro irrigation system, it uses low pressure. Medium pressure is a sprinkler irrigation system. And when the pressure requirement goes very high that is more than 5, we can use a rain gun, we can use centrally pivot irrigation system. So, it depends that how much pressure is needed and accordingly, that particular type of device will be used.

Now, coming to the micro irrigation system. So, what are the specific characteristics of a micro irrigation system? Micro irrigation is a slow application of water on or above or below the soil surface, by using a surface drip system, by using a subsurface drip system, by using a bubbler, or by using a micro sprinkler. So, there are different modes of water application, but relatively the flow rate is small.

In a micro irrigation system, this is another characteristics means, it will depend upon what type of device we are using. So, water can be applied in discrete or continuous drops. It can be tiny streams or it can be miniature spray through foggers or micro sprinklers which are placed along the water delivery line which we say lateral pipeline which is adjacent to the plant row.

A micro irrigation system is also called localized irrigation. Localized irrigation means, it is to emphasize that only part of the soil volume is wetted. Now, the entire field is flooded as in the case of surface irrigation or we just discussed in surface irrigation topic. So, in some literature, this is also called a trickle irrigation system. So, micro irrigation has got different terminologies and in different organizations like the American Society of Agricultural and Biological Engineers, they use a term called micro irrigation. In India, we are using the term, also by Government of India, they also say micro irrigation system means the quite a good number of emission devices, it had been brought under micro irrigation. So, there are different implementing agencies in different parts of the world. They are using different terminologies.

Now, as far as the historical development of micro irrigation is concerned, it is started as early as 1860. In Germany, they used the subsurface irrigation system for irrigating crops. In the USA, this micro irrigation means they give terminology as drip irrigation as early as 1913. Again in 1920, Germany used the perforated pipe to irrigate the crop.

It was Simcha Blass in Israel in 1940, he saw, there is a leaking pipe tap and the plant getting water from this leaking tap, it had vigorous growth, that tree had a vigorous growth as compared to other trees in the vicinity. So, then he thought if instead of irrigating the crop continuously by extreme flow and flooding the field if we apply water drop by drop and he started working on this and then he applied and founded results are encouraging.

And the concept of giving water drop by drop and then bringing a commercial aspect of drip irrigation system came from Israel in 1960. Now, Israel is the leading country who commercialized. In India, we had been doing giving water to the tulsi plant or there are various plants by using earthen peaches. These are our ancient history and historical development it says, but we did not take up these work in a commercial way.

So, it is Israel where they had a severe problem of the water crisis and then the large part of their desert land, they converted to the green valley because of using the drip system. So, in India, this is started, indigenous perforated earthen pipe, perforated bamboo pitcher in the northeastern region and pitcher and porous crops, they started but these were all in a very primitive way, these things were being used.

It started from the research point of view, in research institutions and agricultural universities, they started in 1970. At IIT Kharagpur, we also were started doing this work in the early 80s. We started doing our research work in the early 80s. Later on, the Government of India formed a precision farming Development Centre which we were 22 in numbers which was formed by a national committee of plasticulture application in horticulture that is NCPAH means gave 22 projects in different agro-climatic regions of the country. They did a lot of research work and we also came out our research finding where a large number of farmers, are using a micro irrigation system to the research work carried out in PFDCs.

Now, what are the different micro irrigation characteristics? So, micro irrigation is usually characterized by these features. What is that? Water application is at a slow rate. It is operated for a longer water application time means the duration of water application is large. Then, water is applied at frequent intervals. In a surface irrigation system when we apply water, the irrigation interval could be 2 weeks, more than 2 weeks.

Whereas in the micro irrigation system, this can be done daily or on an alternate day, not more than 2 days irrigation interval. So, the plant root system there means it gets optimum soil moisture conditions. So, better healthy growth of the plant takes place. Water is applied at the root zone means there is nothing like any flooding of water exactly at the root zone water is being applied.

And it is a low-pressure water delivery system and then water is routinely used to transport fertilizer and other chemicals. Means here fertilizers and other agricultural chemicals they can be applied along with the irrigation water which we call fertigation or chemigation. So, chemicals or fertilizers, desired fertilizers, it can be given. Now, you can see here the water is applied in a tiny and here the water is applied in a spray form.

Now, what are the principal crops which are suitable for micro irrigation system, which are giving higher economic returns? So, almost all the crops are suitable under micro irrigation system, but because of its initial investment, some of the crops which are giving higher return in a shorter period like the fruits, vegetable, ornamental plant, flowers, the spices, this has been found suitable.

Now, you can see here, these are the fruit crops where the micro irrigation system has been found highly successful. And then here, we see these flower crops which are being grown; tomato, these are vegetable crops, tomato or variety of crops which are shown here. So, all these crops are suitable. Micro irrigation is also applied to landscaping, greenhouses, and nursery.

Our researches in cereal crops like paddy have also proved that micro irrigation means it requires about 40% saving in water and the yields are at par or more than the conventional irrigation system for irrigating paddy crops. So, like this you know, wheat, rice, and these crops where people were not doing now, these researchers say and then some of the farmers, they have also started using micro irrigation for these crops.

There are some advantages. Why micro irrigation should be implemented? Because it has increased water use efficiency. So, significant improvements in yield have been documented with micro irrigation systems. So, water use efficiency means yield per unit quantity of water used that has been and means it is giving higher result, improved the crop yields and quality. Results mean here, the result due to reduced plant water stress due to slow and frequent water application.

What happened in the case of a surface irrigation system? The plant has to undergo water stress due to the drying phase means there are few days where the rooting system of the plant it goes through the drying phase. And then few days which means when the field is flooded with the water so, there is a waterlogging condition so, the soil aeration is poor. So, that affects the plant, crop yield, and quality of produce.

Reduced non-beneficial use means, here irrigation of smaller soil volume eliminated runoff and controlled deep percolation losses. So, non-beneficial use of the water is eliminated. To a certain extent, we can use saline water means we cannot use as such saline but a certain level

of concentration means the diluted water that can be used by using the saline water which is not possible in the case of a surface irrigation system.

So, what happened? The soil water gets more diluted by maintaining stable soil water conditions when we apply drop by drop by the drip irrigation system. And then the salts get pushed beyond the active plant root zone area because it is maintaining the stable soil water condition. So, the concentration of the salt is pushed out of the effective root zone area.

There are some other advantages. It has got better fertilizer use efficiency. That is the other advantage means a fertilizer, it remains within the root zone depth. So, water, as well as fertilizer used by the plant system is consumed more. Fertilizer use efficiency is better. There is a decrease in energy requirement because it is a low power system, a low energy system. So, the energy requirement is less.

Improved cultural practices, it does not interrupt the cultural operation so, weed infestation, there is a less growth of the weed it takes place. So, that is another advantage and then to a certain extent, one can use the treated wastewater. Now, when we have got a shortage of water supply for irrigation purposes so, treating wastewater and bringing it for irrigation. Micro irrigation can be used as a lot of researchers are being advocated to go for using wastewater using a micro irrigation system.

There are some limitations or disadvantages of a micro irrigation system. It requires extensive maintenance. So, partial clogging of emitters, leakage in the pipe system, and root intrusion take place. There is a salt accumulation near the plants that is another problem. What happened? When we are giving the saline water so, it needs to be applied regularly if we are not applying regularly, breaking the system and giving surface water or there is rainfall. So, that bulb that is maintaining that bulb will break, and then it will come to the soil surface. This is the disadvantage and another thing is that when we are applying saltwater, it is likely that the salt will be deposited at the surface volume.

Restricted root development, when water is being applied on the surface so, root development means it becomes shallow root systems. So, during wind conditions, cyclone condition, plants get uprooted that is the limitation of this system. Therefore, the subsurface drip system is being advocated in order to take care of the development of the root system.

High system cost, no doubt it requires several components which are expensive, but this system cost is partially supported by the Government of India and the state governments. So, this is being restricted.

There is a restricted crop rotation. This limitation usually applies to subsurface drip irrigation systems. So, when the system is adopted, a subsurface drip system is adopted that remains in the soil. So, one can use only certain crops which have the same type of routing pattern, the same depth of routing pattern accordingly, that can be adopted.

In the micro irrigation system, one needs to take care of certain systems which should be considered while designing. So, we will discuss this part in detail when we will come to that design part, it has got systematic design and installation. It requires maintenance consideration. Yes, it requests maintenance in order to get higher life of the micro irrigation system. It requires certain management, anything when we purchase so, maintenance and management is an important component and that should be taken care of in order to get a good response for the system. And then economics, so, an economic part that when we are considering the crop, we need to take care whether this crop is profitable in terms of the yield, in terms of water saving, in terms of early produce, the time of production, all these things are required to be considered while we are deciding.

Now, let us come to the different components of a micro irrigation system. This is very important in any micro irrigation system, water is being taken from the source. So, here this is a pump, pumping can be water, which is being pumped, it is brought to the pipeline. So, it requires filtration and so, it goes to the filter system.

So, after it goes to the filter system, then it comes here in the main pipeline and then subsurface pipeline, then the lateral pipeline, and then on the lateral, there are emitters. So, we can say if I am just putting it, we can say the entire micro irrigation system, it can be divided into a distribution system. A distribution system practically it receives water after it passing through the head control or control system.

So, when we say that the distribution system means here, I am telling you that main pipeline, branch pipeline, submain pipeline. That is your main pipeline, then you are seeing that is the submain pipeline. This is your main pipeline, from it goes to submain, then submain manifold

on the submain manifold there are laterals and on the laterals, these emitters or the emission device.

So, this entire system, we can put it at the emission devices and then control and automation is another part that is your valves and sensors that can be controlled. We will discuss these things in detail when we will come to these topics and then filtration and fertigation are another part. Then the other part is your power supply that which is the type of pump which we will be using and then from where the system means water will be pumped to the system.

Now, there are different types of micro irrigation system. So, let us come to the surface system. The surface drip system uses emitters and laterals that are laid above the ground level. So, you are seeing that this is your submain pipeline and then laterals are attached with the submain pipeline. And then lateral is laid above the land surface and then drippers are attached at an appropriate location in the surface drip system.

So, generally, in a surface drip system, the emitters which are used for delivering discharge that should match with the infiltration capacity of the soil. So, normally these drippers are 1 litre per hour, 2 litre per hour, 4 litre per hour, 6 litre per hour, 8 litre per hour, this should not deliver water that will form runoff. So, the 12 litre per hour is the maximum capacity. It should be always less than 12 litre per hour.

Subsurface as the name says that the pipeline as well as the dripper, are buried below the ground level and these are put up at appropriate depth. So, that the plants receive water exactly at the root zone depth of the plant. Here, the evaporation loss is controlled. So, the evaporation is controlled and then the total life of the system is also large. And this is also possible to provide irrigation as well as fertilizer whether it is a surface system or subsurface drip system, both can be operated and then it has got longer operational life.

Bubbler as you see here, the water supply is being given here, when the quality of water is poor, And when the amount of water is not a limitation, then, in that case, bubbler can be used. When the quality of water is poor means, the drippers are getting clogged, then this bubbler can be used. So, water is applied to the soil surface in a small stream or fountain.

It looks like a fountain opening with the point source, the discharge rate is greater than the 12 litre per hour which is used in a surface or subsurface drip. Usually, their discharge goes up to 250 litres per hour. These are used extensively for irrigating the crops which are say a perennial crop, fruit crops say or orchard crop or they can be also used for landscape. So, for that purpose, the bubblers are used.

Micro sprinklers for close-growing crops and when the quality of water, I am telling you, poor in the sense means a lot of sediments or silt is flowing with the water. So, the orifice size is large, in that case, micro sprinkler and particularly for irrigating close-growing crops like spinach, the crops like fenugreek, dhania such type of crop, it can be irrigated.

So, the air is instrumental in distributing the water. Such micro-sprinklers have got a higher discharge, normally their discharge is less than 175 litre per hour. Of course, it is vulnerable to high wind, because wind drifts the water distribution pattern and also evaporation can take place.

So, those were the devices that I discussed about the different types of micro irrigation systems. These are the references, you can refer to the references which are useful for this topic.

So, let us summarise this particular lecture which I have taken on micro irrigation. So, we discussed about the importance of a micro irrigation system. The historical development of micro irrigation system, what are the characteristics and the principal crops which are suitable for the micro irrigation system. Then what are the different types of this MI system, design consideration, what are the different system components and the types of a micro irrigation system.

In the forthcoming lecture, we will be discussing about drip irrigation system and what are the different types of drip system drippers. We will discuss this in detail in the forthcoming lecture. Thank you very much. Good day.