Micro Irrigation Engineering
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Lecture – 23
Drip Irrigation Introduction and Types

Hello participants, we are now going deeper into the micro irrigation engineering subject. I think, we have covered more than 30% of this particular course and we will be dealing exactly with the title of the subject that is micro irrigation, where drip irrigation is one of the components of micro irrigation.

So, we discussed in the previous class about micro irrigation and then types of micro irrigation system. Here, also we will talk about introduction and types which are there and then we will give the importance, brief introduction about drip irrigation system. What are the different types of drip irrigation system and its components?

So, when we talk of drip irrigation system, it is the application of water at a slow rate virtually in the form of droplets. It can be applied on the surface or below the surface by using a subsurface or surface drip line. On each drip lateral, there are drippers. Now, the principle of water disseminating from drippers dissipates the pressure from the distribution system by using the orifices and following a path of the vortex or tortuous, it can be a long flow path, thus allowing a limited volume of water to dissipate from the drip emitter.

This drip emitters what you are seeing here, this is the one kind of drip emitter which is placed inside the lateral line which we call an inline drip emitter. This is online drip emitters and then we will discuss when we will come to this particular lecture in the coming classes. So, this is the online type of drip emitters. And here, what you see is the water, which is coming out of the drip emitter; it is in the form of a droplet.

So, the emitted water which moves in the soil system, now, this soil is unsaturated means the flow which takes place from this soil system, it is unsaturated flow.

Now, in drip irrigation, in principle, one may say, the water is supplied from a point source. And then the point source, these point source drip emitters are located at a uniform interval

that will depend upon the crop spacing means plan to plant and row to row spacing but normally at the interval of 0.5 meter to 1 meter spacing. Now, each drip source of water creates a moisture pattern that resembles an elliptical or onion shape.

This means, it will depend; the shape will depend upon the soil texture as well as the amount of water or the rate of flow which is being discharged from an emitter. The soil is saturated close to the point source with the gradual decrease in the moisture content in the soil in all directions away from the source of water being supplied. Now, moisture content at any location is subject to a rate of flow means what is the discharge from an emitter.

And then it is soil water-conducting property means basically it is hydraulic conductivity of the soil. Soil diffusivity and conductivity produce the final shape of wetting.

So, the shape of wetting will depend upon the way the particular type of drip emitter is discharging and then the type of soil. So, any lateral has numerous uniformly spaced drip emitters which will produce a series of onion shape moisture content and that is closely linked with each other thus forming a continuous chain of wetted soil masses. So, it makes a uniform water distribution pattern below the soil which is wetting the root zone of the crop.

The size and shape of the chain will depend upon the soil property basically, it is the soil texture and then we can say from the property point of view, it is basically hydraulic conductivity of the soil. The rate of water flows from each point source, the spacing of these sources, and the length of time of application that how long the drip system has been operated.

Now, let us try to see a little comparative performance when the water is being allowed to flow from a drip emitter and when we are comparing it with other methods of irrigation. So, if you know, any soil, we are giving two soil moisture constants so, the upper limit of soil moisture constant which is at with the moisture content is available to the plant in the field capacity. And the lowest most point where plants are not able to withdraw water from the soil is the wilting point.

Now, these 2 points on average, we give in terms of soil water potential. So, it is at field capacity, it is at 0.33 bar and this is at 15 bar. Now, when we are applying irrigation soil

moisture content, if we are seeing here, it is on the ordinate in the y-axis and then days of irrigation that is we can say, this is the irrigation interval. So, irrigation interval when we see, we are taking 3 methods of water application, surface irrigation, then sprinkler irrigation, and then drip method of irrigation.

So, when we are comparing, we see that the water which is given, in case of surface irrigation system, it is normal, it is having a large irrigation interval. So, large irrigation interval when the irrigation water is supplied, the field is flooded with the water. So, it takes some time to come to the field capacity means it is saturation. Then after saturation, the gravitational water is removed, moisture content it comes to the field capacity.

And then it goes to the phase when the soil starts depleting moisture, depletion of moisture through evaporation, through transpiration by the plant, then what happened? It goes to the drying phase and means the moisture content; it goes to that phase which is not desirable for the plant. The next case is a sprinkler irrigation system where irrigation interval is relatively shorter as compared to surface irrigation system.

So, there are also you find this kind of cyclic moisture content variation, takes place in the soil. Moreover, when the water is given through a sprinkler system, it is resembling like rainfall. So, the impact of raindrops, it partially seems to the soil surface. So, the benefit which plants should have is not deriving full benefit, but it is being better response as compared to surface method of irrigation.

But in case of drip irrigation system, which we see that irrigation is given almost daily or in the alternate day when we see that moisture content is near to field capacity. So, this is a comparative difference, how the moisture distribution, it takes place in case of 3 methods of irrigation.

So, under drip irrigation, the soil moisture level does not drop much beyond field capacity. This is what I was stating, in the previous diagram. It means that metric potential is within limit means, it does not exceed 30 to 50 centibars. So, this is at a very low level. Soil moisture tension is not very high. The essential feature of drip irrigation system, is frequent irrigation which is being given and we are maintaining the uniform amount of water and then soil water tension is also low.

This method provides the possibility of establishing a soil moisture regime in which the amplitude of matric and osmotic potential fluctuation during the irrigation cycle are limited and in a controlled manner. This means we are not allowing this is what I am telling that here, the potentials are within the control level. The maximum value reached at the end of a cycle may be kept within a narrow range.

Now, let us compare or try to know what are the different types of drip irrigation system? So, here what you are seeing is the pipe, the dripper, lateral pipeline is laid above the ground level. Here, also you see, it is laid above the ground level and emitters are kept on these, which means they are attached with the lateral. So, lateral pipelines are laid above the ground level. So, the surface drip system uses emitters, and laterals lines are laid on soil surface attached above ground on trellis or tree. Now, drippers can be point source online type of dripper. This dripper can be inline type of dripper. Surface drip irrigation system has been primarily used or wide spacing crops, maybe perennial crops which are say orchard crops. for that, you know surface drip system has been found most suitable and that maintenance also becomes easier.

The discharge rate from these drippers, it varies from 2 litre per hour to 12 litre per hour. So, from a single outlet, one can get this range of the water discharge rate. Furthermore, where the discharge rate is maintained below 12 litre per hour, the reason being that it should not form runoff. So, it should make sure that it is less than the infiltration capacity of the soil so, that it does not form runoff.

In case of subsurface drip, it is evident from these figures. You can see here, very easily, that this drip lateral is placed below the ground level. So, another question is that what would be the depth of placing drip lateral. So, depth of placing the drip lateral is at the effective root zone depth and the drippers in this case is inline type of dripper. So, drippers are fabricated along with the drip lateral.

So, at the time of fabrication of lateral, these drippers are placed at an appropriate spacing depending upon the crop requirement. So, this method of application should not be confused with sub-irrigation. There is another part in sub-irrigation. The water table is controlled.

Here, in subsurface irrigation, the drip lateral is placed and water is being exactly applied at the root zone depth.

Whereas in a sub-irrigation system; water reaches from the water table to the plant root zone by capillary action. So, with little interference with cultivation or other cultural practices and possibly longer operational life. This is another advantage when we are placing subsurface drip lateral, it does not interfere with intercultural operation. So, the life of the drip lateral is relatively more than the surface drip lateral.

And this is typical, you can see this particular, what you are seeing that this is the drip lateral placed below the land surface and then water is a discharging from the drip lateral, it forms the soil moisture wetting and when the time of application is short. So, this kind of you know wetting, it will form, and then it will continue as long as we keep on increasing the time of applications.

So, moisture bulb formation takes place. So, time of application is another equally important thing that yes, we should apply water such that the crop root zone between the 2 rows of the plant they get wetted. So, this is typical of how the 2 rows are being irrigated by a single drip lateral and this is the spacing between the 2 drip laterals, how they are subsurface drip lateral they are it is being shown over here.

Now, from coming to the components of drip irrigation system. A typical drip irrigation system consists of a control head and then another one is a distribution network. Control head when we say means, we are required to keep the all these units which are there under controllers means, there will be pump or overhead tank, then filters, chemical injection equipment, it could be tanks, injectors, backflow prevention device, flow measurement devices, the valves, controllers, pressure regulators, all these are coming under control head. Whereas distribution network consists of main pipeline, sub-main pipeline, laterals, and emitters.

Now, let us see from the figure, a little more detail about these components. So, water is to be taken from the source. Now, this source can be river water; it can be pond water; it can be any lake. Now, here what we are seeing is that there is a canal which is flowing and from the canal, part of this water is brought to a pond where it is allowed for some certain time.

So that, these silt flowing along with canal water that can be settled here and then the water is being pumped by using a pump. So, the adequate size of the pump is used to create adequate pressure, then it goes to a bypass line where the part of the water if the size of the pump is more. So, part of water, it can be allowed to bypass; bring it back to the source and then there is an NRV that is a non-return valve.

So, when we are using say chemical or any fertilizer, so there is a chance that there may be reverse flow and that may contaminate the source of water supply. So, the non-return valve, its purpose is to see that the water is applied only in one direction. Then it comes to the sand separator or hydro cyclone filter. This is a filter to remove the impurity, we will discuss about the filter parts in detail in the coming lecture.

So, this is one kind of filter, then it goes to the venturi injector. This venturi injector, there are different types of you know injectors where the fertilizer or chemical which is in a dissolved form that can be applied along with the irrigation water. So, after it passes from the venturi system, it is allowing to suck the fertilizer, then it comes to the sand filter and after the sand filter, it comes to another filter that is a screen filter.

So, all these filters, sand filter, the sand separator, the sand or media filter, or the screen filter, we will discuss in detail. Practically, the purpose of the filter is to remove the suspended particles which is flowing with irrigation water. Again it comes to the non-return valve. Then from non-return valve, it comes to the main pipeline. So, main pipeline, then again from the main pipeline, there is a control valve.

So, if I want to supply water to this sub-main pipeline, this control valve will be operated, allowed to open or close, and from the sub-main pipeline, lateral pipelines are attached and on these lateral pipelines when it can be as I told you that it would be placed below the soil surface or it can be placed the means above the land surface or below the land surface so, subsurface or surface drip system and on the laterals, drippers are attached.

In order to flush the water from the sub-main pipeline, there is a flush valve. Similarly, there will be a flush valve which is attached in the main pipeline, and then in order to terminate the lateral pipeline, there is end plug is attached over here and as an when we want to flush the

water, clean the drip lateral. So, these you know end plugs are open to flush the pipeline. So, this is in brief about this particular diagram.

Now, briefly let us try to know that how we will select the pump based on the requirement and then try to see that how much is the pressure requirement which we will need. So, that has to be taken care of while selecting the size of the pump. The electric power unit or internal combustion, diesel engine pumps are also used. Prime mover, is selected based on the availability of the system.

Filter, as I told you that there are different types of filters. There could be you know disk filter, screen filter, disk filter, hydro cyclone filter, and sand filters. They are meant to remove the suspended particles before the water enters the pipeline.

The other, you know the valves, etc., are part of the head control unit to allow the water, to pass through, to control the flow into the system. So, these valves are used. And then if there is air entrapped in the pipeline so, air relief valves are used. Check valve or non-return valve, as I explained when I was telling you the check valve is basically to make or to allow only the particular amount of water, control can be made. And non-return valves is to prevent the unwanted reversal of the flow. So, these valves are operated depending on the particular time of operation.

Coming to the water distribution network pipeline. So, the main pipeline, transport the water within the field and distribute it in the sub-mains. The main pipeline is made up of PVC. So, this is the PVC-made pipeline or it could be made up of a high-density polyethylene pipeline. Now, the main pipeline could be 2 inch, 3 as well as 4 inch depending on the requirement.

Sub-main pipeline, these are also made up of PVC or HDPE are LDPE, normally, these are PVC or HDPE. Their sizes will again vary depending on the requirement. It could be from 32 millimeter to 75 millimeter and pressure is about 4.5 kg per square centimeter.

Laterals, as you see they are made up of LDPE that is low-density polyethylene or it can be linear low-density polyethylene and these pipelines are 10 millimeter, 12 millimeter, and 16 millimeter and then on the pipelines, what you see here, this is an inline type of dripper. It is

placed in the lateral pipeline. This is another inline type of tape which you are seeing here that is also attached and or, it can have the online type of drip emitters.

Emitters, as the name, say that emitters, the function of the emitter is to discharge water or they function as an energy dissipater which reduces the inlet pressure to the extent of which 0.5 to 1.5 atmosphere to 0 atmosphere and there are different types of drip emitters. So, on this topic, we will discuss but these drip emitters can be pressure compensating, non-pressure compensating, online, as well as an inline dripper, adjustable discharge dripper, regulated flow dripper, vortex type of dripper, and micro tubing.

So, there are different kinds of drippers which are available. Here, what you see is this one kind of a drip emitter where the inside in this there are 3 components. We will discuss in detail when we will come to this topic. This is another kind of a drip emitter that is an inline type of dripper which is inserted at the time of fabrication and these are you know, what you are seeing this is a button type of dripper. So, there are a variety of drippers which are available commercially, and depending upon the requirement, they are being chosen.

There are other components which are needed, you can see here there are connecting accessories, you want to change the direction of flow, you can have meant this is one elbow; this is the T and like this, you know this is one reducer, from this direction water is coming from a larger pipeline, then it is reduced to another size.

So, such type of devices, these are available and then you can see here that there is a water regulation kind of a thing, air relief valve, flow control ball valve, and the pressure gauge, monitoring system where we can monitor pressure there. This is a flush valve to flush the water, as well as the cleaning of the main or sub-main pipeline, such valves, are used and these are the other accessories which are used for connecting the laterals with the sub-main pipeline or you know closing. This is the end plug which I was told is one end plug. When we want to change the direction of flow or T such types of devices are available.

When we want to operate the drip irrigation system means the operation of the drip system, it is seen that the water pressure in the drip network, maybe in the order of 2.5 atmosphere and one should see that the water when we are required to supply from a drip emitter, so it should have an operating atmospheric pressure of 1 atmosphere. To apply nutrient, materials,

fertilizer and all that, so we need to take care of these nutrient solutions, it is properly dissolved and then it is being supplied at an adequate flow rate.

So, these are the point which one should consider and then these are the references you can refer to in detail on this topic.

And so, let us summarise this lecture. We discussed about the introduction of drip irrigation system, the different types of drip irrigation system, and their components. Now, in the forthcoming lecture, we will discuss about the points which are needed for the design of drip irrigation system and their layout in the field.

So, thank you very much for your patience in hearing and attending this lecture.