1) **What is Micro irrigation?**

- Micro irrigation is defined as the frequent application of small quantities of water directly above and below the soil surface; usually as discrete drops, continuous drops or tiny streams through emitters placed along a water delivery line.

2) **Need of Micro irrigation**

- To make agriculture productive,
- Environmentally sensitive and capable of preserving the social fabric of rural communities
- Help produce more from the available land, water and labor resources without either ecological or social harmony,
- Generate higher farm income
- On-farm and off-farm employment.

3) **Advantages of Drip irrigation**:

- Increased yield
- Early maturity
- Water saving
- Fertilizer saving
- Increased Fertilizer efficiency
- Energy saving
- Labor saving
- Marginal lands can be irrigated
Use of saline water is possible for irrigation

Reduced weed growth

Less problem of disease and pest

Makes interculture operations easy

4) **Soil – Plant – Water Relationships:**

- Soil-plant-water relationships relate to the properties of soil & plants that effect the movement, retention & use of water.

- Soil act as reservoir of water to be used by plants through the roots prevent in the same medium (soil).

- Water is required by plants for the metabolic activities, is an important constituent of cells and more important is a carrier of large amount of nutrients.

- The rate of entry of water into the soil & its retention, movement and availability to roots are all physical phenomena.

5) **Soil Moisture Levels:**

- **Saturated,**

- **Field capacity:** Water content in the soil 1 – 3 days after water has been applied and drainage has ceased.

- **Wilting point:** Water content in soil at which crop yield suffers drastically.

- **Total Available water:** Difference of water content between field capacity and wilting point.
• **Critical Point:** The level below which available water is not allowed to drop. It varies with type of crop, soil & climate.

6) **Micro Irrigation Systems**

- Drip Irrigation (Both on-line and in-line systems)
- Sprinkler Irrigation System
- Micro sprinklers
- Micro jets
- Rain Guns
- Gravity fed Drip System
- Semi permanent sprinkler system

**DRIP IRRIGATION,**

Drip Irrigation is also known as trickle irrigation or micro irrigation, is an irrigation method which saves water and fertilizer by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing, and drippers.

**COMPONENTS OF DRIP IRRIGATION SYSTEM:**

1. **Water Source:**

   The source of water should be open wells, bore wells, canals, rivers, reservoirs etc.

2. **Pump:**

   The water from the source has to be supplied under appropriate pressure and discharge.

3. **Filters:**

   In this drip irrigation system, drippers, laterals consisting of small holes are being used. If foreign particles, leaves, algae, etc. coming with water are not filtered. They will clog the drippers
and drip tape holes resulting in obstructing the water to the plants. To prevent this problem, a filter is connected with the main line.

- Following points should be considered while choosing the type of filter.
  - Efficiency in separating particles larger than the required filtration level.
  - Efficiency, convenience, and simplicity of washing and cleaning process.
  - Filter body: Metal, plastic, fiber glass, or stainless steel.
  - Filtration elements: Disc or Screen.
  - Availability of service and replacement parts.
  - Manual or automatic washing.

- **Sand filter:**
  It stops the impurities and allows only clean water to go ahead, thus preventing clogging of the system. Available in 30, 60, 90 lts.

- **Screen filter:**
A screen filter is a type of filter using a rigid or flexible screen to separate sand and other fine particles out of water for irrigate.

- **Hydro cyclone filter:**

  The principle of hydro cyclone filter is Centrifugal separation of solids from the Water.

- **Disc filter:**

  Primary filter for Bore wells & secondary filter for Open water sources.

  The type of filtration should be selected primarily according to the type of water source, water quality, and required flow rate of the system.

**Table 1: Type of filter selection acc. to water source, water quality & required flow rate:**
<table>
<thead>
<tr>
<th>Water source</th>
<th>Problematic factor</th>
<th>Filter type when problem is mild</th>
<th>Filter type when problem is severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bore wells</td>
<td>Sand</td>
<td>Screen or Disc</td>
<td>Hydro cyclone</td>
</tr>
<tr>
<td>Bore wells</td>
<td>Bacteria+ Iron+ Sulfur+ Manganese</td>
<td>Disc</td>
<td>Disc filter + Chemical treatment</td>
</tr>
<tr>
<td>River, open well Tanks</td>
<td>Clay+ Silt+ Algae+ Organic matter</td>
<td>Disc</td>
<td>Gravel filter + Control</td>
</tr>
<tr>
<td>Effluent water</td>
<td>Algae+ Organic matter</td>
<td>Disc</td>
<td>Gravel filter + Control</td>
</tr>
</tbody>
</table>

4. **Pressure gauge:**

A device indicating pressure in a filter system. Provides a determination of how the system is operating, and informs us when service is required.

![Fig 5: Pressure gauge](image)

5. **Fertigation equipments:**

Venturi, Injector, Fertilizer tank are used for the fertigation.

- **Venturi Injector:**

This system of injection is very low cost and works by creation of partial vacuum in the system and suction of the fertilizers into the irrigation system through Venturi action.

![Fig 6: Venturi injector](image)
The vacuum is created by diverting a percentage of water flow from the main and passing it through a constriction which increases the velocity of flow thus creating a drop in pressure.

When pressure drops the fertilizer solution is sucked into the Venturi through a suction pipe from the tank and from there enters into irrigation stream. The suction rate of Venturi is 30 to 12 lit. per hour.

- **Fertilizer tank:**

  In this system part of irrigation water is diverted from the mainline is flow through a tank containing the fertilizer in a fluid or soluble solid form, before returning to the main line the pressure in the tank and the mainline is same but slight difference in pressure is created between the off take and return pipes for the tank by means of a pressure reducing valve.

  This causes water from main line to flow through the tank causing dilution and flow of the diluted fertilizer into the irrigation system. With this system the concentration of fertilizer entering the irrigation water charges continuously with time.

6. **Non return valve:**

These valves are used to prevent unwanted flow reversal. They are used to prevent damaging back flow from the system to avoid return flow of chemicals and fertilizers into the water source itself in order to avoid contamination of water source. Available in 2", 3" sizes.
7. **Throttle valve:** Throttle valve having gun metal body. It regulates the flow of liquid. Available in 2” and 3” sizes.

8. **Main line:**

   This is PVC pipe line used to carry water from water source to sub-main.

9. **Sub-main line:**

   Sub-main line is also a PVC pipe line that takes water from main line and supply water to the laterals.

10. **Laterals:**
These are source of tubing or drip laterals and are made of LLDPE which quite flexible and strong. These convey water from sub main lines to root zone via drippers.

11. **Drippers:**

Water coming from the laterals reaches the plant root zone through drippers. Types of crop, soil and water requirements are deciding the factors for drippers spacing on the lateral. Drippers may be pressure compensating depending upon field

12. **Emitting pipe:**

Inline drip tubing is an emitting pipe with drippers integrated in the lateral itself. The drippers are integrated inside the lateral at desired spacing. This system can be efficiently used in row crops including vegetable, melons, sugarcane.
Special Features of inline drip tube:

- Made from the high quality linear low density polyethylene material.
- Maximum resistance to blockage.
- Easy to reel out during non-application days.

13. Valves:

Drip system is provided with different types of valves. To control the water pressure,

**Bypass valve** is provided before filter.

**Gate valve** is provided to prevent the pressure difference for the chemigation and fertigation.

**Control valve**<br>Is provided at the inlet of the sub main

**Flush valve** is provided at the end of the sub-main, fitted to facilitate regular Cleaning of main and sub-main.

**Air release valve**
DRIP IRRIGATION SYSTEM DESIGN:

There are two types of Drip Irrigation Systems:

- Online
- Inline

Generally Online Drip Irrigation system is useful for orchard crops like mango, sweet orange, acid lime, Sapota etc. Inline Drip irrigation system is for crops like vegetables, chilies, cotton, onion, banana etc.

Important steps to be followed in drip irrigation system:

- Find out the water availability from the source – Bore / Open well.
- Survey the field to know the topography.
- Consider the peak water requirement of crop.
- Calculate the water requirement of selected crop to arrive the no. of sections required.
- Calculate the head loss of the water delivery system.
- Based on the water requirement and maximum permissible length of lateral, decide the position of sub-main in the field and size of sub-main.

- Each section should provide with a valve.

- Consider the power availability hours while making sections.

**SURVEY:**

For designing of drip system for any crop, we must have the following information initially.

a) Water source details

b) Crop details.

c) Topographic details.

d) Soil details.

e) Climate details.

f) Existing pipe details.

**Water source details:**

- Type of water source: Bore well/ Open well/ Reservoir/ River.

- Location of water source:

- Capacity of water source:

- Available flow rate for irrigation:

- Elevation of water source:

- Quality of water: Total suspended soils, pH, EC, Salinity, Chlorides, Hardness, Organic matter etc.

**Crop details:**
✓ Type of crop:

✓ Crop geometry: Spacing (Row to Row & Plant to Plant).

✓ Duration of growing season:

✓ Age of crop:

✓ Peak daily water requirement of crop:

✓ Duration of irrigation season:

✓ Average annual yield:

✓ Crop rotation:

**Topographic details of the land:**

✓ Elevations:

✓ Undulations:

✓ Dimensions:

✓ Water table level: (below surface)

**Soil details:**

✓ Type of soil: Clay (%), Silt (%), Sand (%)

✓ Characteristics of soil: Physical, Chemical and biological.

**Climate details:**

✓ Daily pan evaporation:

✓ Temperature: Max & min.

✓ Sun shine hours:
✓ Wind velocity:

✓ Overall average annual rainfall:

**Existing pump details:**

✓ Used for: Pressure irrigation / flood irrigation / Domestic use.

✓ Type of pump: Submersible/ Vertical/ horizontal/ mono block/ Coupling set /Split casting/ Electric/ Diesel.

✓ Model of pump:

✓ Capacity (H.P):

✓ Head range:

✓ Discharge range:

✓ Suction X delivery size:

✓ Static head if the pump:

✓ Average daily available electricity:

**ENGINEERING SURVEY**

**Distance measurements:** Distance between the pegs should be measured by holdings. Measuring tape is in straight line.

**Angle measurement:** Angle should be measured by using tie length method.

- For a three concerned figure no angle need to be measured.

- For four concerned closed figure, only one angle need to be measured.

- For a five concerned figure, two consecutive angles are required and so on.
No angle                                      one angle                                  one consecutive
angle

Elevation: The slope of the plot should be judged with eye where possible it should be mentioned in the survey map, showing percent of slope and direction.

Water source: Water source, existing pipe lines with their sizes, should be clearly marked on the survey map.

Water sample: Run the pump at least 10 mins. Collect the water 1lit. in a clean bottle with tight lid. Water sample has to research the laboratory within 24hrs.

Soil sample: Soil sample should be collected from a depth of 1 foot below the ground level at different places. Thoroughly mix the samples and divide in to 4 parts. Fill it in 1 kg polythene bag, seal it and send it to laboratory.

- As A first step in the proper design of the irrigation system, it is necessary to know the crop water requirements. To determine the crop water requirements following factors are to be taken into consideration.

1) Type of crop and its age.

2) Type of soil.

3) Evaporation loss from the surface.

4) Transpiration loss from leaves.
5) Canopy area and root zone development.

6) Plant to plant and row to row spacing.

7) Wind velocity and humidity. Etc

1. **Crop stage / Age of plant:**

   Water required by a plant varies as per its growth stages. Water requirement is different at the time of sowing, when the plant is growing, at the flowering stage, at the time of fruiting, ripening, and harvesting.

2. **Saturation Capacity or Minimum Water Holding Capacity:**

   In this condition the soil fully saturated and all the soil pores are filled with water. In this plant roots gets suffocated due to absence of air in the root zone and cannot uptake water properly.

3. **Field Capacity:**

   It is defined as the amount of water held in soil after excess water has drained away and the moisture content has become relatively stable. At field capacity large soil pores are filled and the micro pores are filled with water. In drip irrigation the soil moisture content is always maintained at field capacity level.

4. **Permanent Wilting Point:**

   It is the soil moisture content at which plants can no longer obtain enough water to meet transpiration needs and remain wilted even if water is added to the soil.

5. **Transpiration:**

   It is the evaporation of water from plant surfaces directly into the atmosphere or into intercellular spaces and then by diffusion through the stomata to the atmosphere.
6. **Evapotranspiration (ET):**

   It is also called as consumptive use. It donates the quantity of water transpired by plants during their growth or retained in the plant tissue plus the moisture evaporated from the surface of the soil and the vegetation.

7. **Reference Crop Evapotranspiration (Et0):**

   It is defined as the rate of Evapotranspiration from an extend surface of 8 to 15 cm tall green grass cover of uniform height, actively growing, completely shading the ground and not short of water.

8. **Crop factor or Crop Coefficient (Kc):**

   The Crop Factor is selected for given crop and stage of crop development under prevailing climatic condition. For each crop there are four growth stages. The crop factor for initial stages is lower than (0.3 to 0.4) and it increases to (0.7 to 0.8) during the crop development stage. It is about 1.0 to 1.1 at fully grown stage and it reduces again to 0.8 to 0.9 at the harvesting stage.

9. **Canopy factor:**

   The canopy factor indicates the growth of crop at different stages. It is expressed as the ratio of the area covered by plant foliage to the total area provided for the plant. Thus, it is the ratio of plant's shadow area at 12 noon to the area of the plant. The area is provided to a plant is the product of plant spacing and row spacing.

   - **Water requirement for Tree crops:**

     Daily water requirement per tree (liters) = \( \frac{A \times B \times C \times D}{E} \)

     Where, \( A = \text{Evaporation rate in mm/day} \), \( B = \text{Crop factor} \), \( C = \text{Canopy factor} \)
D = Area of plant = (plant spacing x row spacing),

E = Efficiency of the irrigation system (0.8 for the drip, 0.8 for the sprinkler system)

First we have to calculate the water availability.

\[ 75 \times \text{Pump HP} \times (\text{Pump efficiency (0.85)} \times \text{Motor efficiency (0.75)}) \]

\[ \text{WATER AVAILABILITY} = \frac{75 \times \text{Pump HP} \times (\text{Pump efficiency (0.85)} \times \text{Motor efficiency (0.75)})}{\text{Head (m)}} \]

- Head = Installation Depth (m).

If bore well, Add 14 to water depth.

If Open well, Add 20 to Water depth.

\[ \text{hausted} \]

\[ \text{SLLECTION OF MAIN LINE:} \]

Table 1: Carrying Capacities of mainline.

<table>
<thead>
<tr>
<th>PVC Pipe</th>
<th>Flow Rating (LPH)</th>
<th>Head loss range/ 100 m Length of run</th>
</tr>
</thead>
<tbody>
<tr>
<td>40mm</td>
<td>1800-3600</td>
<td>0.8-2.9m</td>
</tr>
<tr>
<td>50mm</td>
<td>3600-6480</td>
<td>0.95-2.82m</td>
</tr>
<tr>
<td>63mm</td>
<td>6480-10800</td>
<td>0.81-2.08m</td>
</tr>
<tr>
<td>75mm</td>
<td>10800-18000</td>
<td>0.88-2.28m</td>
</tr>
<tr>
<td>90mm</td>
<td>18000-28800</td>
<td>0.93-2.23m</td>
</tr>
</tbody>
</table>
Head loss calculation:

To Calculate the Head loss we use **Hazens-Willioms** formula

\[ J = 1.526 \times 10^4 \left( \frac{Q}{C} \right)^{1.852} D^{-4.87} L \times F \]

Where,

- \( Q \) = Flow rate in m³/hr.
- \( C \) = Constant,
- \( D \) = Inside pipe diameter in cm.
- \( L \) = Length of pipe in meter

→ **Head loss in Straight pipe (\( H_f \))**

\[ H_f = f l \frac{v^2}{2gd} \]

Where,

- \( f \) = Coefficient of frictional loss,
- \( l \) = Length between two consecutive points (m),
- \( v \) = Average velocity of flow (m/s),
- \( g \) = Acceleration due to gravity (m/s²),
- \( d \) = Dia of the pipe (m).

The flow velocity can be calculated as

\[ V = 1.274 \frac{q}{d^2} \]

Where

- \( v \) = velocity (m/s)
- \( q \) = volume flow (m³/s)
- \( d \) = pipe inside diameter (m)

☞ **WATER REQUIREMENT** =
For Online: No. of plants x Dripper discharge x No. of drippers

- No. of plants = Area / (lateral spacing x Dripper spacing)
- Dripper Discharge = we can use 8lph or 4lph
- No. of drippers = Above 8 years use 8 no. of drippers
  For new plants use 4 no. of drippers.

For Inline: ----------------------------------------------- x Dripper discharge (Lateral Spacing x Dripper Spacing).

**SELECTION OF SUB-MAIN LINE:**

- **Specific discharge rate**: (Water Requirement / Sub-main length)

  - Water Requirement
  - **No. of sections**: -----------------------
  - Water Availability

  TO select the **running length** sub-main, take nomographs and select the sub-main size, take the value of SDR at 1m head loss. Some SDR values are taken to measure the approximate running length of sub-main as given below.

**Table 2: Running lengths sub-main for different SDR**

<table>
<thead>
<tr>
<th>Sub-main SDR</th>
<th>Length of sub-main run (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Did 40mm</td>
</tr>
<tr>
<td>30</td>
<td>115</td>
</tr>
<tr>
<td>32</td>
<td>110</td>
</tr>
<tr>
<td>35</td>
<td>102</td>
</tr>
<tr>
<td>No.</td>
<td>42</td>
</tr>
<tr>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>45</td>
<td>87</td>
</tr>
<tr>
<td>50</td>
<td>84</td>
</tr>
<tr>
<td>56</td>
<td>72</td>
</tr>
<tr>
<td>62</td>
<td>68</td>
</tr>
<tr>
<td>66</td>
<td>65</td>
</tr>
<tr>
<td>78</td>
<td>59</td>
</tr>
<tr>
<td>85</td>
<td>52</td>
</tr>
<tr>
<td>98</td>
<td>50</td>
</tr>
<tr>
<td>104</td>
<td>46</td>
</tr>
<tr>
<td>120</td>
<td>36</td>
</tr>
<tr>
<td>132</td>
<td>33</td>
</tr>
<tr>
<td>140</td>
<td>30</td>
</tr>
<tr>
<td>166</td>
<td>29</td>
</tr>
<tr>
<td>196</td>
<td>29</td>
</tr>
<tr>
<td>222</td>
<td>25</td>
</tr>
<tr>
<td>236</td>
<td>25</td>
</tr>
<tr>
<td>252</td>
<td>23</td>
</tr>
<tr>
<td>281</td>
<td>23</td>
</tr>
<tr>
<td>300</td>
<td>22</td>
</tr>
<tr>
<td>315</td>
<td>22</td>
</tr>
<tr>
<td>332</td>
<td>22</td>
</tr>
<tr>
<td>348</td>
<td>21</td>
</tr>
<tr>
<td>370</td>
<td>21</td>
</tr>
<tr>
<td>400</td>
<td>20</td>
</tr>
<tr>
<td>450</td>
<td>19</td>
</tr>
<tr>
<td>515</td>
<td>18</td>
</tr>
<tr>
<td>555</td>
<td>17</td>
</tr>
<tr>
<td>700</td>
<td>16</td>
</tr>
<tr>
<td>850</td>
<td>20</td>
</tr>
<tr>
<td>1000</td>
<td>20</td>
</tr>
</tbody>
</table>

**Emitter Selection:**

Total area to be wetted

\[
\text{No. of emitters} = \frac{\text{Total area to be wetted}}{\text{Radius of wetted area of a single emitter}}
\]

Radius of wetted circle: Thumb rule

- Sandy soil = 2 to 3 feet
Loamy soil = 4 to 5 feet
Clay soil = 6 to 8 feet.

**Formula for computing emitter spacing:**

- Spacing (feet) = 3.3 x F

  F = is a factor from the table below

**Table 3: Emitter discharge in different soils, for different flow rates:**

<table>
<thead>
<tr>
<th>Soil</th>
<th>Emitter discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2lph</td>
</tr>
<tr>
<td>Light (Sandy soil)</td>
<td>0.3</td>
</tr>
<tr>
<td>Medium (Loamy soil)</td>
<td>0.7</td>
</tr>
<tr>
<td>Heavy (Clay soil)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Dripper discharge is given by the following formula

\[ Q = KP^{(X)} \]

Q = Discharge in lit/hr

P = Operating pressure head, m

K = Constant

X = Constant

The constant X depends on the flow regime in dripper. Most drippers have turbulent flow and n=0.5, that means discharge varies as square root of pressure head. Minimum flow variation **10%**, the corresponding permissible variation in pressure head is **20%**.

**LATERAL SELECTION:**

It is made of LDPE (Low Density Polyethylene). The size of the lateral varies from 12mm to 16mm internal diameter with wall thickness varying from 1 to 3mm.
(Dripper discharge x No. of drippers per plant)

- **Specific discharge rate:**

Lateral spacing (m)

- To find the length of lateral run from the table below:

These values are calculated from namographs

### Table 4: Length of lateral run in different plant spacing:

<table>
<thead>
<tr>
<th>Plant spacing</th>
<th>Dripper Discharge (lph)</th>
<th>Drippers per plants</th>
<th>Specific discharge rate</th>
<th>Max. Length Of lateral run (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12 mm</td>
</tr>
<tr>
<td>10x10 m</td>
<td>8</td>
<td>4</td>
<td>3.2</td>
<td>50</td>
</tr>
<tr>
<td>9x9 m</td>
<td>8</td>
<td>4</td>
<td>3.55</td>
<td>45</td>
</tr>
<tr>
<td>8x8 m</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>42</td>
</tr>
<tr>
<td>7x7 m</td>
<td>8</td>
<td>4</td>
<td>4.57</td>
<td>38</td>
</tr>
<tr>
<td>6x6 m</td>
<td>8</td>
<td>4</td>
<td>5.33</td>
<td>35</td>
</tr>
<tr>
<td>5x5 m</td>
<td>8</td>
<td>4</td>
<td>6.4</td>
<td>30</td>
</tr>
<tr>
<td>4x4 m</td>
<td>8</td>
<td>4</td>
<td>8</td>
<td>26</td>
</tr>
<tr>
<td>4.5x2.7 m</td>
<td>8</td>
<td>4</td>
<td>5.9</td>
<td>32</td>
</tr>
<tr>
<td>1.8x1.8 m</td>
<td>4</td>
<td>2</td>
<td>4.44</td>
<td>40</td>
</tr>
<tr>
<td>1.8x1.5 m</td>
<td>4</td>
<td>2</td>
<td>5.43</td>
<td>35</td>
</tr>
</tbody>
</table>
### Irrigation Data Calculation:

1. **Application rate (Online):**
   
   \[
   \frac{\text{(Dripper Discharge} \times \text{No Of drippers)}}{\text{(Lateral Spacing} \times \text{Plant Spacing)}}
   \]

2. **Application rate (Inline):**
   
   \[
   \frac{\text{Dripper Discharge}}{\text{(Lateral Spacing} \times \text{Dripper Spacing})}
   \]

### Irrigation Time:

- **Peak water requirement**

- **Daily duration of operation:**

---

<table>
<thead>
<tr>
<th>Emitting pipe</th>
<th>Dripper Discharge (lph)</th>
<th>Dripper spacing (cm)</th>
<th>Specific discharge rate (Dripper discharge/Dripper Spacing)</th>
<th>Max. length of lateral run (m) for 1m Head loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-02-40</td>
<td>2</td>
<td>40</td>
<td>5</td>
<td>62</td>
</tr>
<tr>
<td>16-04-40</td>
<td>4</td>
<td>40</td>
<td>10</td>
<td>45</td>
</tr>
<tr>
<td>16-04-50</td>
<td>4</td>
<td>50</td>
<td>8</td>
<td>50</td>
</tr>
<tr>
<td>16-04-60</td>
<td>4</td>
<td>60</td>
<td>6.66</td>
<td>60</td>
</tr>
</tbody>
</table>
### Application rate

**Daily duration**

- **Duration of one operation:**  

**No of operations**

---

**Table 5:**

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Crop</th>
<th>Peak water requirement (mm/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mango</td>
<td>2.3</td>
</tr>
<tr>
<td>2</td>
<td>Sapota</td>
<td>2.3</td>
</tr>
<tr>
<td>3</td>
<td>Coconut</td>
<td>2.5</td>
</tr>
<tr>
<td>4</td>
<td>Sweet orange &amp; Acid lime</td>
<td>3.0</td>
</tr>
<tr>
<td>5</td>
<td>Papaya</td>
<td>6.0</td>
</tr>
<tr>
<td>6</td>
<td>Guava</td>
<td>3.5</td>
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<tr>
<td>7</td>
<td>Cashew nut</td>
<td>3.0</td>
</tr>
<tr>
<td>8</td>
<td>Grapevine</td>
<td>5.5</td>
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<tr>
<td>9</td>
<td>Pomegranate</td>
<td>4.9</td>
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<tr>
<td>10</td>
<td>Custard apple</td>
<td>3.0</td>
</tr>
<tr>
<td>11</td>
<td>Ber</td>
<td>3.3</td>
</tr>
<tr>
<td>12</td>
<td>Banana</td>
<td>6.6</td>
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<td>13</td>
<td>Vegetables</td>
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<tr>
<td>14</td>
<td>Onion</td>
<td>8.0</td>
</tr>
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<td>15</td>
<td>Chilies</td>
<td>8.0</td>
</tr>
<tr>
<td>16</td>
<td>Turmeric</td>
<td>8.0</td>
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<tr>
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<td>Ginger</td>
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</tr>
<tr>
<td>18</td>
<td>Leafy vegetables</td>
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<tr>
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<td>Crop</td>
<td>Irrigation system</td>
</tr>
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<tr>
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<td>Mango</td>
<td>Drip – online</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drip – online</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Drip – online</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drip – online / inline</td>
</tr>
<tr>
<td>2.</td>
<td>Sapota</td>
<td>Drip – online</td>
</tr>
<tr>
<td>3.</td>
<td>Coconut</td>
<td>Drip – online</td>
</tr>
<tr>
<td>4.</td>
<td>Cashew nut</td>
<td>Drip – online</td>
</tr>
<tr>
<td>5.</td>
<td>Sweet orange</td>
<td>Drip – online</td>
</tr>
<tr>
<td>6.</td>
<td>Acid lime</td>
<td>Drip – online</td>
</tr>
<tr>
<td>7.</td>
<td>Guava</td>
<td>Drip – online</td>
</tr>
<tr>
<td>8.</td>
<td>Custard apple</td>
<td>Drip – online</td>
</tr>
<tr>
<td>9.</td>
<td>Ber</td>
<td>Drip – online</td>
</tr>
<tr>
<td>10.</td>
<td>Amla</td>
<td>Drip – online</td>
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<tr>
<td></td>
<td>Description</td>
<td>Method</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>11</td>
<td>Pomegranate</td>
<td>Drip – online</td>
</tr>
<tr>
<td>12</td>
<td>Grapevine</td>
<td>Drip – inline</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drip – online</td>
</tr>
<tr>
<td>13</td>
<td>Banana</td>
<td>Drip – inline</td>
</tr>
<tr>
<td>14</td>
<td>Papaya</td>
<td>Drip – inline</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drip – online</td>
</tr>
<tr>
<td>15</td>
<td>Vegetables – Tomato, Brinjal, Bhendi, Cabbage, Cauliflower, Capsicum, Potato &amp; Gherkins</td>
<td>Drip – inline</td>
</tr>
<tr>
<td>16</td>
<td>Spinach, Fenugreek, Coriander &amp; beans</td>
<td>Sprinkler or Microjet or MicroSprinkler</td>
</tr>
<tr>
<td>17</td>
<td>Bottle gourd, Bitter gourd, &amp; Ridge gourd</td>
<td>Online drip system</td>
</tr>
<tr>
<td>18</td>
<td>Onion &amp; Garlic</td>
<td>Drip – inline or Microjet or MicroSprinkler</td>
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<tr>
<td>19</td>
<td>Chilli</td>
<td>Drip – inline</td>
</tr>
<tr>
<td>20</td>
<td>Turmeric</td>
<td>Drip – inline or Microjet or MicroSprinkler</td>
</tr>
<tr>
<td>21</td>
<td>Ginger</td>
<td>Drip – inline or Microjet or MicroSprinkler</td>
</tr>
<tr>
<td>22</td>
<td>Roses</td>
<td>Drip – inline</td>
</tr>
<tr>
<td>23</td>
<td>Jasmine, Gladiolus &amp; Chrysanthemum</td>
<td>Drip – inline</td>
</tr>
<tr>
<td>24</td>
<td>Crossandra</td>
<td>Micro jet/Microsprinkler</td>
</tr>
<tr>
<td></td>
<td>Plant</td>
<td>System Type</td>
</tr>
<tr>
<td>---</td>
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<td>---------------------</td>
</tr>
<tr>
<td>25</td>
<td>Sugarcane</td>
<td>Drip – inline</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td>26</td>
<td>Cotton</td>
<td>Drip – inline</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Tobacco</td>
<td>Drip – inline</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Groundnut</td>
<td>Drip – inline or Sprinkler / Rain gun</td>
</tr>
<tr>
<td>29</td>
<td>Sunflower</td>
<td>Drip – inline or Sprinkler</td>
</tr>
<tr>
<td>30</td>
<td>Soybean</td>
<td>Sprinkler</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Sesamum, Castor &amp; Safflower</td>
<td>Sprinkler</td>
</tr>
<tr>
<td>32</td>
<td>Maize, Jowar, Ragi, Bajra, Upland Rice, Korra</td>
<td>Sprinkler / Rain gun</td>
</tr>
<tr>
<td>33</td>
<td>Green gram, Black gram, Red gram, Bengal gram</td>
<td>Sprinkler / Rain gun</td>
</tr>
<tr>
<td>34</td>
<td>Mulberry</td>
<td>Drip – inline</td>
</tr>
<tr>
<td>35</td>
<td>Drumstick</td>
<td>Online drip</td>
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<tr>
<td>36</td>
<td>Betelvine</td>
<td>Inline drip</td>
</tr>
<tr>
<td>37</td>
<td>Aswagandha</td>
<td>Inline drip</td>
</tr>
</tbody>
</table>
 INSTALLATION & COMMISSIONING:

Important instructions to farmers: before installation

Our company engineer or dealer’s representative will visit the field in which drip irrigation is to be installed and mark the outline for excavating the trenches for laying the sub-main and mainline pipe lines and location of filters as per design.

It is the responsibility to get the trenches dug within the specified time to avoid the delay in installation of drip irrigation system. The width of trench should be 45 cm to 70cm and the depth of the trench should be 75 cm or as instructed by representative. The trenches should be in straight line. Please ensure that there are no stones or any sharp objectives in the trenches.

For filter station a leveled, hard surface is required. A plat form of brick masonry or cement concrete should be constructed. The size of the platform is on the size of sand filter.

Installation of drip irrigation system can be divided into 3 stages:

A. Installation of filter station
B. Connecting main line and sub-mains

C. Laying laterals with drippers / Inline drip system

A. Installation of filter section:

* Install the screen or sand filters in the correct position on the leveled plot form such that adequate space is available for cleaning of filters and for keeping fertigation equipment.

* Ensure that all the fittings such as pressure gauge, backwash, bypass and air release valves are done properly.

* Check that filter candles and mushrooms are fixed in proper position, and then fill the sand up to the level marked on the filter.

* Fig 16: Source: Bore well (Only screen filter)
Fig 17: Source: Bore well (Screen filter and Hydro cyclone filter)
Fig 18: Source: Open well / Pond (Standing water)

Fig 19: Source: Open well / River (Moving water)
B. **Sub-main and mainline connections:**

* Mains and sub-mains are PVC pipeline should be laid at a depth of minimum 2 feet below the ground surface to avoid possible damage to pipe lines due to the farm implements used for various cultivation operations in the field.

* After installation of filter, main pipeline is laid starting from the filter outlet. Air release valve and sectional valves are provided on mainline at appropriate locations. Air release valves are normally installed at points of higher elevation on the mainline and sub-mains.

* Sub-mains are connected to the mainline using various fittings like Tee, Elbow, etc. Adequate amount of solvent cement is used to ensure perfect bonding at joints.

* A flow control valve (ball valve) is provided at the beginning of each sub-main. A flush valve is provided at the end of each sub-main to facilitate flushing of sub-main. The flush valve should be located at the 6 inches above the ground so that the impurities can be flush out easily. Flush valve should not be fixed in a vertical position; it should be fixed horizontally after providing an elbow so that water will not be spread on the person while flushing.

**PVC PIPES LAYING, JOINING AND TESTING:**

1) **Storage:**

* Pipes are made from PVC are strong through light weight, being about one fifth the weight equivalent steel or cast iron pipes. As a result pipes made of this material are very easily handled and there s a tendency for them to be thrown.
II. UPVC Pipes should be staked on reasonably flat surface free from sharp projections and stones. A layer of sand should be spread evenly over the storage area.

III. Side supports should be provided at the interval of 2m.

IV. The pipes should not be staked more than 1 m high and the pipes of different sizes and classes should be staked separately.

V. Socketed pipes should be stacked in layers with the sockets pointing in opposite direction in alternate layers so that each pipe will have an even bearing throughout its entire length. Care should be taken that no load is carried by the sockets in the bottom layer.

VI. Pipes should be all times stored in a manner that the ends are not exposed to danger of damage.

VII. On no account pipe should be stored in a stressed and bend condition. The pipes should be stored under cover.

2) Handling of PVC pipes:

I. Care should be taken in handling PVC pipes to avoid damage to the wall surface.

II. Pipes should not be dragged along rough ground.

III. The loading and unloading of pipes should be carried out by hand.

IV. Pipe should not be dropped on the hard surface.

3) Transport:

I. Vehicles with a flat bed should be used for the transport of pipes. The bed should be free from nails or other projections. They should be supported uniformly along its length.
II. When loading socket and spigot pipes, these should be stalked in alternative layers so that the sockets do not carry any load.

III. Overhang should not be more than 1m.

4) Laying and Jointing:

I. Trench width and depths should be such that the pipes can be laid and jointed easily.

   Width = Outside dia. + 300mm (Min.)
   Depth = Outside dia. + 1150 (Min.)

II. Pipes should be lowered slowly in the trench. While lowering it should be ensured that the pipe ends do not touch the trench to avoid any damage to pipes as well as soil collapse in the trench.

III. Back fill material with practice size of 12.7 mm dia. Or less should be used to surround the pipe. It should be placed in layers.

IV. Apply the solvent cement with nylon brush.

V. Do not apply excess solvent cement on the bell socket.

VI. Immediately after applying the last coat of cement, forcefully insect the male end of pipe into the socket. Turn the pipe to distribute the cement evenly.

VII. Estimated solvent cement requirements:
5) Testing PVC Systems:

Whenever possible, PVC piping system should be tested hydrostatically prior to being put into service. Water is normally used as testing fluid. To test the piping system, water is introduced through 1 inch. Dia or small pipe a cock valve or other means should be available to bleed air from the system. Water is introduced at least point in the system with air being bled off the higher point.

Gradually bring the system up to desired pressure rating. The test procedure should be exceed the rated operating pressure.

C. Installation of lateral pipes:

<table>
<thead>
<tr>
<th>Outside dia of pipe(mm)</th>
<th>Inside dia of pipe(mm)</th>
<th>Approx. No. of Joints/ lit. of PVC Solvent cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>½</td>
<td>350</td>
</tr>
<tr>
<td>25</td>
<td>⅝</td>
<td>300</td>
</tr>
<tr>
<td>32</td>
<td>1</td>
<td>250</td>
</tr>
<tr>
<td>40</td>
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<tr>
<td>50</td>
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<tr>
<td>75</td>
<td>2 ½</td>
<td>103</td>
</tr>
<tr>
<td>90</td>
<td>3</td>
<td>79</td>
</tr>
<tr>
<td>110</td>
<td>4</td>
<td>54</td>
</tr>
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<td>140</td>
<td>--</td>
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<td>07</td>
</tr>
<tr>
<td>315</td>
<td>--</td>
<td>05</td>
</tr>
</tbody>
</table>
To connect the lateral lines to the sub-mains, holes are drilled on the PVC sub-main pipes using appropriate drill guide and drill.

Grommets are fixed in the holes and take offs are fixed on the grommets. Laterals are then connected to the take offs.

Sufficient extra length of lateral is provided at the end of the last tree to account for snaking effect and shrinking allowance.

**Installation of emitting pipe**

Emitting pipe may be laid on the surface or buried.

It should be laid straight with emitter outlet placed in the root zone. To prevent the snaking of the lateral, use C clip tube holding stake is recommended.
1. Screen filter
2. Screen filter drain valve
3. Throttle valve
4. Non return valve
5. Sand filter
6. Sand filter Drain valve
7. Backwash Assembly
8. Fertilizer tank
9. Main line
10. Control valve
11. Lateral
12. Flush valve

**Fig 21: Drip Irrigation System**

**PVC fittings & Accessories:**

- Elbow
- Tee
- End caps
COMMISSIONING OF Drip Irrigation System:

- Ensure that the required design & Drawings are available prior to installation.
- Check that the material received is free from any defect and damages.
- Check that the trenches are done as per the layout.
- Check that the installation is done as per drawing.
- Make sure all drippers are spaced as per design.
- After installation do not fill up the trenches immediately before test run.
- Keeping flush valves and laterals end open, start on the flush off the start.
- Check the system for the leakages by adjusting the design pressure for each section.
- It is advisable to install a pressure check point at the inlet of each section.

EVALUATION OF Drip System:
**Emission uniformity:**

In order to determine whether the system is operating at acceptable efficiency, evaluate the uniformity of emission by calculating EU.

\[
EU = \frac{\text{Minimum rate of discharge per plant}}{\text{Average rate of discharge per plant}} \times 100
\]

**EU Value** | **System performance**
---|---
Greater than 90% | Excellent
Between 80-90% | Good
Between 70-80% | Fair
Less than 70% | Poor

**OPERATION AND MAINTENANCE:**

*After sales services - responsibilities:*

**Supplier:**

- Providing irrigation & fertigation schedule.
- Providing guidelines for maintenance of the system.
- Demonstration of the services.
- Conducting awareness programs for the use of system.
- Providing maintenance schedule.
- Providing basic information on crops.
- Immediate response to feedback.
User:

- Reading the guidelines carefully.
- Understanding the basic concepts of drip irrigation & Create the awareness among the field operator.
- Understanding the function of each component of the system and its maintenance requirement.
- Making the operator aware of maintenance schedule.
- Train the field operator for operation & maintenance of the system.
- Passing the feedback / complaints immediately to supply.

Maintenance

A. Daily maintenance:

Following activities should be carried out daily:

- Start the pump and allow the pressure to become stable. Open the drain valves of the screen filters and hydro cyclone filters to remove the debris. Backwash the sand filter.

  **Back washing** is the process in which the flow direction is reversed so that the water flows upwards through the sand bed. The sand gets lifted up and expands allowing it to release the dirt arrested in it, the dirt then driven out of the filter through the back wash valve. Back washing of the sand filter should be strictly done in the following sequence.

    - Open the Backwash valve.
    - Close the outlet valve
    - Open the bypass valve.
Close the inlet valve.

Back wash operation is complete when clear water starts flowing out through the backwash valve. To resume the filtration process again.

Fig 23: Back-wash cleaning of sand filter

Manual cleaning process is open the cap of the sand filter before starting the system and remove all dust, algae and other dirty particles manually,

- After cleaning the filters, operate the by-pass valve of the header assembly to obtain the desire pressure in the system. It should be about 1-1.5 kg/cm² at the inlet of filter and 1.1 kg/cm² at the inlet of the sub-mains.

- Take a round of the entire field and check if there is any leakage at joints or damage to any component of the system. Rectify the defects if any by replacing the spares. Remove the folds or kinks on the lateral if found, and make them straight.
Check the drippers for uniformity of discharge. Open and clean the drippers which are not emitting water. Do not pull the emitter when cleaning; it will enlarge the hole on the lateral causing leakage.

After irrigation over, check whether the wetting patterns of the drippers are uniform or not.

Check the position of the drippers, if drippers are misplaced, place them at proper location.

Remove the end stops and flush the laterals, and flush the sub-main at the end of the irrigation cycle.

B. Fortnightly Maintenance:

After completing the steps 1 – 8 of the daily maintenance, perform the following operations at every 15 days.

- Sand filter: The pressure difference between the inlet and outlet of the filter is an indicator that suggests whether filters need cleaning. Difference is more than 0.5 kg/cm², it means filter needs cleaning.
  - Open the lid of the sand filter.
  - Allow the water to come out through the lid opening. Adjust the flow using bypass valve such that sand does not come out of the opening.
  - Stir the sand thoroughly by moving the hand through entire sand media from top to bottom. Be careful and do not disturb the position of black filter candles provided at the bottom, else sand may enter the screen filter.
  - Break the lumps of the sand by squeezing in hand.
Ensure that half the filter is filled with sand up to the level marked on the filter. Add new sand if it is below the mark.

Allow water flow till clean water starts flowing out of the opening.

Put the lid back in position tightly.

* **Screen filter**: The fine particles and dirt which are escape through the sand filter are arrested on the filtering element of the screen filter. This affects the filtering process. Therefore, it is essential to clean the filtering element every 15 days. For this, open the lid of the screen filter and take out the filtering element. Remove the rubber seal from both ends of the filtering element, reverse them clean with water and fix them tightly on the element again. Rinse the element in the flowing water gently with hand, and clean it. Do not use wired brush, as it may damage the screen.

![Cleaning of Screen filter](image)

**Fig 24: Cleaning of Screen filter**

**C. Monthly Maintenance:**

* If the salts, algae and other impurities present in the water enter into the drip irrigation system, then the laterals and drippers are get clogged and may stop emitting water.
Therefore, it is necessary to apply acid and chlorine treatments once in a month or as recommended in the water quality analysis report. The procedure and calculation of doses for acid and chlorine treatment are explained in detail in Acid treatment.

- Perform the treatment to remove precipitated salts from drippers and pipeline network.
- Perform chlorine treatment to remove bacterial slime, algae or other biological contamination.
- Inspect all the components above ground for physical abuse, damage by field machinery rats, squirrels etc.
- Do not perform both acid and chlorine treatment simultaneously.

D. Half yearly maintenance:

- Change the sand of the media filter with new one as sand particles get rounded off due to continuous abrasion during operation.
- Check out the system wear and tear, replace the spares whenever required.
- Make necessary maintenance of the pump as per instructions given by the pump manufacturer.

**CHEMICAL TREATMENT IN Drip IRRIGATION SYSTEM:**

*The injection of acid into drip irrigation system is primarily carried out to:*

1) Presence of large particles as well as suspended silt and clay load in the source water.

2) Growth of bacterial slime in the system
3) Growth of algae in the water source and in the drip system

4) Bacterial precipitation of iron or sulphur

5) Chemical precipitation of iron

6) Chemical precipitation of dissolved salts in lateral, drip tapes and drippers.

For acid treatment any one of the following acids can be used.

a. Hydrochloric Acid

b. Sulphuric Acid

c. Nitric Acid

d. Phosphoric Acid.

Material and accessories required.

1) A plastic bucket or jar

2) An empty water bottle of 1 lit volume

3) A dropper (available in any medical shop)

4) pH paper that indicates color change according to pH shifts

5) Hydrochloric acid (it is normally readily available in the market).

Procedure:

Step 1: Estimation of volume of acid required for treatment

i. From the water source used for drip system, take 1 lit of water in a plastic bucket or jar.
ii. Add acid drop by drop in this 1 lit water using a dropper. Stir the water well and measure its pH value.

iii. Continue the above process till the pH value of water is equal to 4.

iv. Note the quantity of acid in ml required to obtain pH value of 4,

v. The time required for water to reach the furthest dripper can be physically measured in the field by noting the time of starting the pump and the time when water reaches the last dripper of the section. A fair estimate of this can also be obtained by dividing the total length of mainline + sub-main + lateral by the velocity of flow 1.5m/s. If a section of a field has 900 m pipe length, the time taken to reach the last dripper is 900/105 seconds. i.e. 600 seconds or 10 min.

vi. Note the flow rate of the section to be treated from the design. If the system flow rate is not known, then use the value of "nominal flow rate in m3/hr written on the filter of the system. Say the system flow rate 25m3.

vii. Calculate the quantity of acid required for the treatment of the selected section as given below.

Acid required for 1lit water for attaining pH value of 4 = 2ml.

Motive flow in the section just to fill the section (total flow in 10min) = (25000/60) x 10 = 4166.67 lit.

Volume of acid required for acidulating 4166.67 lit water = 4166.67 x 2ml = 8.33 lit. Thus approximately 9 lit. Of acid will be required to treat the section.

Step 2: Injection procedure:

i. To avoid injection of commercial acid directly to the Venturi, mix the estimated quantity of acid (9 lit in this case) in an equal amount of water in a plastic bucket.
ii. It is recommended to use a Venturi tube assembly for the acid injection. Connect the Venturi to the manifold of filter. Start the pump.

iii. First, begin closing the Throttle valve keeping the suction tube of the Venturi assembly outside the bucket contains acid. Water comes out of the small filter attached to the suction tube of the Venturi assembly.

iv. Continue closing the throttle valve till the outward flow of water from the suction tube stops and air bubbles start moving into the tube in the reverse direction.

v. Place the tube inside the bucket with acid solution keeping the filter end below the surface of the acid solution.

vi. Check the pH of water at the nearest dripper of the section. If pH is observed to be more than 4, then increase the suction rate by slightly closing the valve.

vii. In this way throttling the valve allow the acid mixed water having pH value of 4 to reach up to the last dripper. Close the sub-main valve or switch off the pump. Keep the system closed for 24 hrs. It takes minimum 6 hrs for the salts in the system to dissolve in the acid mixed water.

viii. After 24 hrs open the sub-main flush valve and the ends of all laterals. Start the pump and flush out the entire system so that all acid and dissolve the salts are driven out of the system.
Fig 25: Chemical or Acid treatment procedure