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Importance of Drip Irrigation System Installation and Management - A Review

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Abstract:

Management of the drip irrigation system requires proper knowledge of the system, climate and suitable environmental conditions for the cultivated crops. To achieve good management practices for drip irrigation, the impacts of climate variables on plant growth and production during different seasons should be understood. The planning of irrigation system and installation of components in the right way is considered one of the most essential matters to ensure the highest efficiency possible use of available irrigation water and allows the plants to benefit from the most water used. Assessment of the irrigation system and improving its efficiency involves many variables, the details concerning the parts of the irrigation system and also the method of its management and maintenance. Periodic maintenance of the irrigation system is very important, especially when the irrigation system is compact and by drip, for the sustainability of the irrigation system and ensure no poor distribution of water efficiency. The maintenance includes repair and replaces any of the parts of the irrigation system to prevent leaks and closures. Also, it includes maintenance and washing the filter and irrigation pipes to remove the accumulated impurities and salts. This paper describes the drip irrigation system components, installation, and management of the users which are required for the different stakeholders in the agricultural sector.

Keywords: Drip irrigation, management, components, filtration unit, biological control.

INTRODUCTION

No matter who we are or where we live water is a key component of our daily life. Although most of the earth's surface is covered by water, however, the water available for agriculture is decreasing day by day. Owing to an increase in population, industrialization, increase in area under agriculture and scanty rainfall causing depletion in the water table. Due to globalization of trade and economic liberalization of policies it has become inevitable to use modern irrigation technologies in agriculture, especially in horticultural crops to obtain higher yields of good quality products and to earn good revenue by the farming community (Berbel *et al.*, 2018). Micro-irrigation systems including sprinkler irrigation are once a system wherein higher yields of superior quality products can be obtained from crops by utilizing the available water resources in a limited quantity (Du *et al.*, 2015). Drip irrigation is an incredibly efficient watering method that slowly delivers water directly to a plant's root system, through a network of small pipes (Plusquellec, 2009). This eliminates water loss due to evaporation which is common in other types of irrigation techniques i.e. flooding (Ahadi *et al.*, 2013). This is also called micro-irrigation. This method of irrigation is suited for the crop with wide spacing, whereas, sprinkler irrigation is suitable for crops which are closely spaced (Lecina *et al.*, 2010).

If we don't have good soil, we can use hydroponics. If we don't have a good climate, we can use greenhouses or net-houses. But if we don't have water, we simply cannot grow anything. Drip irrigation is the most effective form of watering plants (Gonzalez, 2015). Drip irrigation is 40% more efficient because it uses 40% less water than conventional irrigation methods. Fertilizer usage can also be optimized this way (Smith *et al.*, 2016). Essential nutrients can be applied more directly resulting in better uptake by the plants. It also helps in crop protection, particularly the use of plant protection products to improve the health of the plants (Wu

et al., 1983). As the demand for food is rising day by day because the world population is constantly increasing. Therefore, to increase the yields from food crops, the use of plant protection products is a must. Use of irrigation systems with less impact on the environment, such as drip irrigation which can also be used for the distribution of systemic plant production products (Najafi *et al.*, 2007). This is much more sustainable than spraying them on the leaves. It is also important to stay up to date with trends in water consumption technologies. Periodic maintenance of the irrigation system is very important, especially when the irrigation system is compact and by drip, for the sustainability of the irrigation system and ensure no poor distribution of water efficiency. The maintenance includes repair and replaces any of the parts of the irrigation system to prevent leaks and closures. Also, it includes maintenance and washing the filter and irrigation pipes to remove the accumulated impurities and salts (Lamm *et al.*, 1995).

Advantages of drip irrigation

- Drip irrigation saves about 30-60% of water, and with the saved water more area can be brought under irrigation.
- Saves labor and electricity.
- Enables the application of the required quantity of water uniformly to all the plants at one time.
- Enables the application of the water-soluble fertilizers through water and enhances savings in fertilizer cost.
- Control weeds and soil erosion.
- Enable the use of saline water for irrigation.
- Enables to obtain higher yields of good quality produce.

Components of drip irrigation

There are three main components of the drip irrigation system which are as follows;

1. Water source and pump
2. Filtration Unit
3. A network of pipes.

a. Water Source and Pump

The water source could be an open well, bore well, or a canal. A pump can be installed depending upon the availability of water and area to be irrigated.

b. Filtration Unit

The filtration unit consists of filters, pressure gauge, venturi, and fertigation tank. The water is filtered by different filters before it is lead to the drip system. There are mainly 3 types of filters i.e. hydro-cyclone filters, sand/media filters, and screen/disc filters. Suitable filters are installed according to the impurities found in the source of water (Arshad *et al.*, 2017).

c. Network of pipes

The network of pipes consists of main lines, sub-main lines, laterals, dippers/emitters, and control valves. The diameter and the length of these components are determined by the design of a system and accordingly, emitters are found depending upon the water requirement of the crop (Arbat *et al.*, 2010).

Design of the System

Drip irrigation is a mechanical system that feeds water to a known number of plants under appropriate pressure ranging from 1.0 – 2.0 kg / cm². Hence, once should have a thorough and sound knowledge to design a drip irrigation system scientifically by considering and adopting details about the region, topography, and soil types of the land source and quality of water as well as the spacing, stage, and age of the crop. The important criteria while designing a drip irrigation system are the outflow from the pump should be equal to the outflow from the drip

system. If the outflow from the pump is less and the area to be irrigated is more than partitioning of the area is required (Arshad *et al.*, 2014).

Quality of the Material

Quality of the material used in different components of a drip irrigation system is important because most of the time it remains on soil exposed to the climatic conditions and hence should be capable of tolerating the changing climatic conditions and last long (Bosch *et al.*, 1992). The materials should and must be of ISI standards with the ISI marks with the respective number of components paste on it.

Points to be followed during installation

The availability of water and the amount of water required by the crop should be determined prior to installation. Water to be used in drip irrigation should be checked for its suitability before using it. A suitable pump should be installed depending on the water yield and pressure to be developed for the drip system. Normally pressure of 1.5 – 2.0 kg/cm² is required for drip irrigation; while 3.0 – 5.0 kg/cm² for sprinkler irrigation (Bucks *et al.*, 1981). The water filters used depends on the source of irrigation water. If the source of water is a bore well with less physical impurities only screen filters can be installed. If a source of water is an open well or a canal screen/disc filters along with sand and hydro-cyclone filter has to be installed. Mainline and sub-main lines should be installed in a telescopic manner i.e. pipes with a larger diameter should be connected first followed by pipes with a smaller diameter (Camp *et al.*, 1993). This facilitates maintaining uniform pressure in the system besides reducing the cost and providing the required quantum of water uniformly to all the plants. The mainline and sub-main lines should be buried at least 45 – 50 cm deep to prevent them from getting damaged during cultural operations mechanically. Based on the availability of water crops to be grown and spacing 12mm or 16mm laterals should be installed.

For widely spaced crops 12mm laterals and for closely spaced crops 16 mm laterals can be used. Depending upon the pressure normally 250 to 300 liters of water is discharged from a 12mm lateral while 450 to 500 liters of water per hour from a 16mm lateral pipe. In the main field, laterals should always be installed across the slope (Hills *et al.*, 2001). Depending on the type of crop and soil characteristics the number of drippers and their discharge capacity is determined. Normally for widely spaced crops, 4 drippers are provided at different places at the base, 2 drippers for crops with medium spacing and for closely spaced crops like vegetable and flower crops drippers are provided at every 30 to 45 cm intervals all along the lateral pipe (Lamm *et al.*, 1997). End caps should be provided at the end of each section at about 2 ft above the surface to facilitate the removal of physical impurities from the drip system. For every section of the pipe, an air release valve should be connected at a height of 1 meter from the ground surface to prevent the sucking of mud by the drippers. After the connection is complete open the end-caps of all laterals in all the sections and runs the water for about half an hour later close all the end-caps of laterals and check for leakage and rectify if any (Najafi *et al.*, 2007). Check for stones or any sharp objects before closing the channels made for laying the drip lines. In case of heavy vehicles moving on the orchard, it is advised to bury the drip lines deeper.

Management of the System

Drip irrigation is a mechanical system that performs at a certain pressure of water; if the system has to perform well for a long time the pressure should be maintained properly. Even if good quality materials are used and installed in a scientific manner there is a possibility of failure, if the field maintenance is not proper and regular. Therefore, the management of the system is of prime importance. Periodic maintenance of the irrigation system is very important, especially when the irrigation system is compact and by drip, for the sustainability of

the irrigation system and ensure no poor distribution of water efficiency (Grabow *et al.*, 2006). The maintenance includes repair and replaces any of the parts of the irrigation system to prevent leaks and closures. Also, it includes maintenance and washing the filter and irrigation pipes to remove the accumulated impurities and salts.

Major Problems in the Drip Irrigation System

- Clogging of the laterals and emitters preventing and easy flow and uniform distribution of water.
- Leakage in different components of the system.
- Quick wear and tear of the material.
- Damage to the components from the different farm animals.

Among these items, laterals and drippers are more prone to clogging. The main reason for clogging is the pressure of different physical impurities in water i.e. tiny sand/soil particles, organic substances, chemical impurities (calcium carbonate/salts of fertilizers), and biological impurities of (microorganism and algae). The problems encountered due to physical impurities can be overcome by proper management of the different components in the system. Whereas, the problems encountered due to chemical and biological impurities can be over by acid treatment and chlorination respectively (Adin *et al.*, 1991).

Control of Biological Impurities

• Management of filters

Regional type of suitable capacity filters should be compulsory installed depending on the quality of water. The impurities collected in the filters should be cleared daily, fortnightly or monthly intervals. And it should be flushed and cleaned once a week.

- **Management of the Section and Laterals**

The end-caps in the sections should be opened and the system should be operated for at least half an hour to remove the physical impurities collected at the ends. Similarly, the impurities in the laterals can also be expelled by opening the end-caps of the laterals.

Control of Chemical Impurities

Chemical impurities can be controlled by using the acid treatment and chlorination.

- **Acid treatment**

The drippers and laterals clogged by various chemical impurities including fertilizer residues (if any), used for fertigation can be removed by treating the system either with Hydrochloric acid, Sulphuric acid, or Nitric acid. Among these, a Hydrochloric acid at (25%) dose is best for the treatment.

Method of Acid Treatment

The known amount of hydrochloric acid in water; pump it into the system through a venturi or a fertigation tanks after the system is filled with water. Allow acid solution into the system until a pH of 4.0 is reached both at a starting and at the last emitter. Retain this mixture for 24 hours. The acidified water in the system reacts with the salts deposited in the system and dissolves it. After 24 hours the acidified water along with the dissolved salts comes out of the system by flushing. The following precautions should be taken during acidification:

- a) Hand gloves should be used to prevent the acid from coming in contact with hands.
- b) Acid should be added to water but not water to acid.
- c) Unidirectional valves should be installed to prevent the backflow of acidified water.

- d) The mixing of acid can vary depending on the output of the water from the pump.
- e) The mixing of acid should be started after keeping the system in running condition and all the distribution channels are filled with water.
- f) The pH of the acidified water let into the system should be checked with a litmus paper or pH meter regularly at random so as to maintain a pH of 4.0 throughout the system.
- g) After acidification of the system flush the system with fresh water for some time until the acid solution is removed from the system.

- **Chlorination**

Chlorination is done to remove the biological impurities collected in a drip irrigation system. Chlorination can be done either by using Calcium hypochlorite, Sodium hypochlorite, Chlorine or Calcium hydrochloride (Bleaching powder).

Method of Chlorination

Soak the required quantity of bleaching powder in water 1 day before treatment. Let the solution into the system through a venturi or a fertigation tank and allow it to stay in the system for 24 hours. Later on, open the end-caps of the sections and laterals. Run the system for about an hour so that the impurities are thrown out of the system. The duration and dosage of the chlorine acid treatments are elaborated in Table 1.

Table 1. Duration and dosage of the chlorine acid treatments.

Agents	Duration	Dosage
Algae	Regular intervals	1-2 mg / liter of water
Bacteria	Once in 2-3 months	10-20 mg/liter of water
Complete clogging of drippers/emitters	Super chlorination	500 mg/liter of water

Control of Uneven Distribution of Water in the System

The main reason for the uneven distribution of water in the system is due to the difference in the pressure of the water. A minimum pressure of 1.5 – 2.0 kg / cm² in drip irrigation, while for sprinkler irrigation, a minimum of 3.0 – 5.0 kg/cm² pressure should be maintained. Sometimes the water pressure reduces due to the clogging of the filters. Therefore the filters should be clean regularly.

Prevention of leakage in different components

The different drip components and laterals should be checked regularly for leakage of water and rectified immediately. Leaky washers and laterals should be replaced with good quality new ones immediately. Ensure the use of good quality products that are manufactured from a

well-reputed company and have an ISO certification. Avoid the use of products manufactured from reusable plastics. The drip irrigation components are likely to be damaged by cattle, rats, and squirrels in the field. Care should be taken while grazing cattle and the laterals should be rolled and kept aside while plowing. To control rats and squirrels a field should be kept clean or keeping water bowls at 3 or 4 places along the drip lines will help in controlling them to a certain extent. The scientific installation of drip irrigation does not mean that there is no need for maintenance. To obtain good results field maintenance of the drip irrigation system is a must along with proper designing use of good quality materials. Water requirements of different horticultural crops are elaborated in Table 2.

Table 2. Water requirements of different crops.

Crop	Spacing	Water Requirement	No. of Drippers
	(ft)	Liters / day	
Banana	6 x 6	20	2
Papaya	6 x 6	20	2
Mango	30 x 30	100-150	4
Sapota (Chiku)	30 x 30	100-150	4
Coconut	30 x 30	69-100	4
Grapes	11 x 22	40	4
	6 x 4	10	2
	8 x 6	20	2
Pomegranate	12 x 12	40	3
Lemon	18 x 18	40	3
Figs	12 x 12	20	2
Guava	15 x 15	50	3
Jujube (Ber)	12 x 12	40	3
Custard Apple	12 x 12	50	3
Rose	3 x 3	5	1
Jasmine	9 x 9	15	1
Water Melon	6 x 8	20	2
Flowers and Vegetables	60 x 45 cm (double row system)	6-8 liters / m ²	For every 45 cm

The above set quantities mentioned are the maximum water requirements of the crops. It may vary depending upon the soil type, area to be grown, and rainfall of that region respectively (Maina *et al.*, 2017).

CONCLUSION

Drip irrigation is an incredibly efficient watering method that slowly delivers water directly to a plant's root system. This eliminates water loss due to evaporation which is common with overhead watering devices like sprinklers or flooding. To achieve good management practices for drip irrigation, the impacts of climate variables on plant growth and production during different seasons should be understood. Periodic maintenance of the irrigation system is very important, especially when the irrigation system is compact and by drip, for the sustainability of the irrigation system and ensure no poor distribution of water efficiency. The users may increase the efficiency and durability of the drip irrigation system by maintaining its components and installation planning which is necessary for the enhancement in the agricultural sector.

RECOMMENDATIONS

Running the irrigation system at frequent intervals (daily in summer) as much as possible if the salinity of irrigation was high because this will work on dissolving salts and not to allow time for its deposition, as well as removing salts and reducing its concentration in the wet areas where the plant roots are present. Do not try to clean up the closed units of flow using sharp tools or in strong ways. Check the irrigation system in the field on a permanent basis for any closings, as the closing in flow units is usually

found at the end of the line first. Do the work required when observing any problems. Wash all sub-pipes containing units of flow-through opening the ends of a specified number of pipes to ensure that there is adequate pressure to remove impurities from the system and leave it for a period of approximately 3 minutes. Do so with the rest of the pipes so that the clean water comes out of all endings. Washing the end of all the main and secondary irrigation lines from impurities, sand, and salt. Folding all secondary pipes and put it in a shady place away from sunlight. Make sure to bury all the major pipes existed in the field. Make sure to close the ends of the pipes in the field to ensure that there is no accumulation of sand inside it. Removing the filters of the field crops and fertilizer injectors in a shady spot, washing and cleaning them well to use it in the coming season.

CONFLICT OF INTEREST

There is no conflict of interest.

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