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Role of Micro-Irrigation in Vegetable Crops

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***Abstract* – In present scenario, our aim to increase the agricultural production per unit volume of water in per unit cropped land. The slogan "more crop per drop" perfectly fits water use efficiency. Micro-irrigation is the slow application of water as discrete or continuous drops, tiny streams or miniature spray on, above, or below the soil by surface drip, subsurface drip, bubbler and micro-sprinkler systems. It is applied through emitters connected to a water delivery line through low-pressure delivery. Hence better management of available water resources through more efficient methods of water application like drip irrigation under condition of protected cultivation assumes great significance in enhancing the yield and water productivity. The fertigation allows application of right amount of plant nutrients uniformly to the wetted root zone where most of the active roots are concentrated and this helps to enhance nutrient use efficiency. It has been found to improve the productivity and quality of crop produce along with improved resource use efficiency. The growth and yield of tomato crop significantly increased under micro sprinkler irrigation as compared to other methods of irrigation. Drip irrigation adoption in sweet pepper increased water use efficiency (60-80%), saved water (20-60%), reduced fertilization requirement (20-33%) through fertigation, produced better quality crop and increased yield (7-25%) as compared with conventional irrigation. Drip irrigation coupled with fertigation showed significant advantages in terms of yield and economic returns of cucumber compared with overhead irrigation and conventional fertilization practices. Thus, micro-irrigation system has vital importance in terms of sustainable management of soil and water resources.**

***Keywords* – Fertigation, Irrigation, Sprinkler and Yield.**

I. INTRODUCTION

Water is fundamental for life and health. It is essential for human, animal and plant life. Without water life is not possible on earth. More than 70% of the earth's surface is covered with water. Irrigation is the artificial application of water to the land or soil. When more than half of a water requirement for a crop is supplied through irrigation, it is considered as irrigated crop. Agricultural water is used for irrigation, pesticide and fertilizer applications, crop cooling and frost control. However, growing competition for scarce water resources has led to applying modified techniques for maximizing water use efficiency and improving crop yield and quality in arid and semi-arid regions (Abdelraouf, 2015).

Agriculture is the largest user of water in India. 90% of India's water is used by agriculture and livestock, 7% by municipalities and 3% by industry. Irrigation accounts for 55-70% of water usage in India, out of which 60% goes, wasted due to inefficient methods of irrigation. The use of agricultural water makes it possible to grow fruits, vegetables, pulses and raise livestock, which is a main part of our diet. Agricultural water is used for irrigation, pesticide and fertilizer applications, crop cooling and frost control. According to FAO (2011), irrigation typically doubles farm yield and the number of crops grown in one year is increased from 1 to 2. Irrigated land is more than twice as productive as rain-fed cropland. Farmers are sometimes slow to change what they sow and continue to grow thirsty crops like rice and sugarcane. They meet these irrigation demands by indiscriminately extracting ground water, which some say accounts for a quarter of the world's groundwater usage.

Micro Irrigation

Frequent application of small quantities of water directly above and below the soil surface, usually as discrete drops, continuous drops, tiny streams, or micro spray, through emitters or applicator placed along a water delivery line. To irrigate and fertigate the plant instead of soil.

II. STATUS OF MICRO IRRIGATION IN INDIA

India's current irrigation coverage of 48.7% of total sown area means two-quarters of the population engaged in farming are dependent on monsoon rainfall. At the national level, an area under micro irrigation is about 4.97 lakh ha has been covered till 31st December, 2017.

During 2017-18, an amount of Rs. 1610.00 crore and Rs. 594.90 crore has been released to states for micro-irrigation and for "Other Intervention" respectively under Per Drop More Crop. Just five states - Andhra Pradesh, Karnataka, Gujarat, Maharashtra, and Tamil Nadu – account for 78% of the coverage expansion during 2017-18. While Punjab added 274 hectares area under micro-irrigation system.

Types of Micro Irrigation

1. Drip irrigation system.
2. Sprinkler irrigation system.
3. Micro jet irrigation system.
4. Micro sprinkler system.
5. Bubbler irrigation system.
6. Rain gun irrigation system.

1. *Drip Irrigation System*

In this system, water is delivered directly to the soil near the roots of the plant through a special outlet device called an emitter or dripper. Water is supplied drip by drip at very slow rate 2-10 lph. The term trickle or drip irrigation are used synonymously. It was developed by an Israeli engineer in 1964. It saves 40-70% water as compared to conventional method of irrigation. The increase in yield ranged from 20% to as high as 100%.

Components of Drip Irrigation System

- Pump - to lift the water from the source of supply.
- Head - the water lifted from the source of supply is stored in a head tank.
- Central distribution system - It is connected to the main water supply which regulates water pressure and quantity.
- Fertilizer tank - connected to the central distribution system to supply soluble plant nutrients along with irrigation water.
- Filtration system - Filtration of irrigation water is essential to prevent clogging of emitters due to presence of salts in water, micro-organisms, suspended organic or inorganic matter, clay, silt *etc.*
- Main line - The mains are PVC pipes usually of 25 mm to 75 mm in diameter to deliver the desired dischar-

-ge. PVC pipes are generally available in 2.5, 4.0, 6.0 and 10.0 kg/cm pressure rating.

- Sub main - The sub main distributes the same discharge to all the laterals fitted to it.
- Laterals - The laterals are provided in the main line or on sub main for each row of the crop.
- Drippers or emitters - Plastic drippers are inserted in the laterals at the desired spacing (equal to the intra-row spacing of the plant) which control the release of the desired quantity of water.

Types of Drip Irrigation System

a) Surface drip irrigation system.

b) Sub surface drip irrigation.

c) Continuous flow drip irrigation.

**Drip Irrigation is Useful for Crops*

Vegetable crops in which drip irrigation method is used are Cabbage, Cauliflower, Potato, Chilies, Radish, Brinjal, Capsicum, Bhindi, Beans, Cucumber, Ash gourd, Lettuce etc.

2. *Sprinkler Irrigation System*

Sprinkler irrigation is a method of applying irrigation water which is similar to natural rainfall. Water is distributed through a system of pipes usually by pumping and through sprinklers water delivery is more than 1000 lph and operating pressure required 2.5bar. It is then sprayed into the air through sprinklers so that it breaks up into small water drops and cover area more than 10m.

Components of Sprinkler Irrigation System

- Water source - open well, tube well, canal etc.
- Pumping unit - centrifugal, submersible.
- Main pipe lines and lateral pipe lines, riser pipe, sprinklers.
- Other accessories are - elbows, gauges, valves, filters.

Types of Sprinkler Irrigation System

a) Rotating head type.

b) Perforated type.

3. *Micro Jet Irrigation*

In micro jet irrigation, water leaves the jet at a pressure of nearly one bar. This gives throw distances of 1 to 4 m with a correspondingly larger wetted area of ground. The water discharge of the jets is 5 to 160 l per hour i.e. much higher than that of the drippers in a drip irrigation system. Depending on the design and operating pressure, micro jets produce coarse or fine spray i.e. varying degrees of atomization of the water jet and varying droplet sizes.

In this method, much higher water discharge than drippers in drip irrigation system and the main objective of

this system are to emit water in the form of small droplets without causing any misting.

4. *Micro Sprinkler Irrigation*

The micro sprinklers irrigation method is normally designed to spray water to cover an area of 1 to 6 meters with a flow rate varying from 20 lph to 220 lph. Their operating pressure varies from 0.8 to 4.0 bar.

The individual micro sprinkler is able to wet a much larger area of ground than a dripper and throw distance 0.9 to 4m. The micro sprinklers irrigation method is normally designed to spray water to cover an area of 1 to 6 meters with a flow rate varying from 20 lph to 220 lph. Their operating pressure varies from 0.8 to 4.0 bar.

The individual micro sprinkler is able to wet a much larger area of ground than a dripper and throw distance 0.9 to 4m.

5. *Bubbler Irrigation System*

Bubbler irrigation, a relatively new system, is designed to reduce energy requirements through inexpensive, thin walled, corrugated plastic pipe. The disadvantages in drip irrigation i.e. High energy consumption to pump water with pressure for distribution, clogging of drip emitters and damages to delicate screen filters are all avoided. From the lateral buried irrigation tubes rise open vertical tubes of 1 to 3 cm diameter.

6. *Rain Gun Irrigation System*

Rain gun is a high pressure, high volume, large diameter sprinkler irrigation system. These are used to cover more area for irrigation. There are semi-permanent and permanent rain guns. These sprinklers have a discharge ranging from 10,000 l/h to 32,000 l/h and radius throw from 24 m to 36 m. These systems require high pressure and high discharge pipes & pumps to operate them. These are preferred for irrigating crops spread over large areas in short time.

Comparison between Conventional and Micro Irrigation System

Performance Indicator	Conventional Irrigation Method	Micro Irrigation Method
Water saving	Waste lot of water due to percolation, runoff, evapotranspiration.	40-50% can be saved
Water use efficiency	30-50 % due to high losses	80-95%
Labour requirement	More	Less
Weed infestation	High	Less due to less wetting of soil
Pest and diseases	More	Less due to less atm. Humidity
Soil type	Not suitable for all types of soils	Suitable for all soils
Water control	Inadequate	Very precise and easy
Efficiency of fertilizer use	Low due to leaching and runoff	High due to less losses
Soil erosion	High	Low due to less wetting of soil surface

Fertigation

Fertigation is a process, in which fertilizer is dissolved, diluted and distributed along with water in drip or spr-

-inkler irrigation system. In other word, fertigation is the process of application of water soluble solid fertilizer or liquid fertilizers through micro irrigation system.

What Should be Considered in Fertigation?

1. *Irrigation System & Injector Pump:*

Drip irrigation system is utilized for vegetable production. Injector pumps such as piston pump and venture type are recommended.

2. *Water Quality:*

Sediments in the water can plug the emitters in drip hoses.

3. *Water Supply:*

Adequate supply of water demanded by the crop.

4. *Fertilizers:*

It is essential that nutrients used for fertigation are soluble.

Objectives of Fertigation in Micro Irrigation

- Main objective of micro irrigation is to maximize the profit by applying right amount of water and fertilizer at right time.
- It minimize the adverse environmental effects by reducing leaching losses of fertilizers and other chemicals below root zone.

Suitable Fertilizer for Fertigation

Fertilizers which are having high nutrient content in a form readily available to plants and highly soluble at field temperature conditions. They must be fine - granule product and having no chemical interaction between the fertilizer and irrigation water. Water soluble fertilizers like MAP, SOP, and MKP *etc.* are applied through fertigation while others like normal fertilizers *e.g.* urea, potash *etc.* are used.

Table 1. Effect of different levels of fertigation and foliar application of nutrients on capsicum.

Treatments	Number of Fruits Per Plant	Average Fruit Weight (gm)	Fruit Length (cm)	Fruit Diameter (cm)	Fruit Yield (t/ha)
50% Fertigation + 50% Foliar	**20.27**	**84.03**	**7.24**	**6.80**	**62.88**
70% Fertigation + 30% Foliar	19.29	83.29	6.67	6.55	59.25
30% Fertigation + 70% Foliar	19.07	80.18	6.22	6.76	56.51
80% Fertigation + 20% Foliar	19.01	81.26	6.56	6.56	57.03
100% Fertigation	19.24	82.17	6.37	6.63	58.43
100% Foliar	19.27	79.70	6.30	6.71	56.73
Control	17.88	78.14	5.46	6.35	51.62

Kaur *et al.* Fatehgarh Sahib (2017)

Kaur *et al.* (2017) at Fatehgarh Sahib reported that the number of fruits per plant, average fruit weight, fruit length, fruit diameter and fruit yield of Capsicum is maximum by applying 50% nutrients through fertigation and 50% by foliar application.

Table 2. Effect of drip and micro sprinkler irrigation on growth and yield of tomato.

Treatment	Height (cm)	Yield (kg/ha)	Water used efficiency (kg/ha/mm)
Drip irrigation	**94.90**	53,600	**153.14**
Micro sprinkler system	93.80	**54,200**	115.12
Surface irrigation	87.25	40,000	72.72

Kakhandaki *et al.* 2012.

Kakhandaki *et al.* (2012) reported that the plant height of tomato crop is higher in drip irrigation method and yield is more by micro sprinkler method while water use efficiency is also maximum in drip irrigation method.

Table 3. Effect of irrigation methods on growth and yield of potato.

Treatment	Plant height (cm)	Tubers/plant	Tuber yield/plant (g)	Tuber yield (q/ha)	WUE (kg/ha/mm)
Furrow irrigation with 180 kg N/ha	24.9	3.0	244	23.88	34.11
Furrow irrigation with 220 kg N/ha	26.0	3.1	300	26.50	37.86
Furrow irrigation with 260 kg N/ha	28.0	3.6	344	**28.51**	40.81
Drip irrigation with 180 kg N/ha	29.7	3.1	325	30.59	72.93
Drip irrigation with 220 kg N/ha	33.5	3.3	389	35.21	83.83
Drip irrigation with 260 kg N/ha	**38.2**	**3.7**	**417**	27.23	**88.64**

Solaimalai *et al*., 2005

Solamalai *et al*. (2005) reported that drip irrigation with 260 kg N/ha gives maximum plant height, more tubers per plant and water use efficiency while maximum tuber yield per hectare with furrow irrigation with 260 kg N/ha.

Table 4. Lettuce yield responses to different drip irrigation levels under open field condition.

Parameters	I_{25} (75% deficit)	I_{50} (50% deficit)	I_{75} (25% deficit)	I_{100} (100% full irrigation)	I_{125} (25% excessive)
Yield, g plant^{-1}	390	673	**997**	897	578
Plant height , cm	25.0	30.2	**33.5**	31.3	29.3
Plant diameter , cm	12.7	13.1	**21.4**	19.3	13.9
Core diameter , cm	8.3	9.0	13.3	**17.3**	13.7
Head firmness , (1-5)^{ns}	2.7	3.3	**4.3**	3.7	3.0
Chlorophyll	19.3	22.8	19.9	**25.7**	21.7
No. of total leaves	65	69	**109**	101	78

Bozkurt and Mansuroglu, 2011.

Bozkurt and Mansuroglu, 2011 reported that the treatment I_{75} gives the best result with maximum yield per plant, maximum plant height, maximum plant diameter, more head firmness and maximum no. of total leaves while treatment I_{100} with 100% irrigation gives maximum core diameter and chlorophyll content.

Table 5. Effect of drip irrigation and cultivation methods on the yield and quality of parsley roots.

Cultivation Methods	Irrigation Treatments	Length of Roots (cm)	Dry Matter Content of Roots (%)
Ridges	Subsurface	21.37	**27.99**
	Surface	**21.60**	27.70
	Without irrigation	21.17	26.99
	SEM±	21.38	27.56
Flat ground	Subsurface	17.00	26.26
	Surface	**17.40**	26.28
	Without irrigation	17.37	**27.31**
	SEM±	17.26	26.62

Kaniszewski *et al*., 2008.

Kaniszewski *et al*., 2008 reported that with ridges cultivation method surface irrigation gives maximum length of roots while maximum dry matter content of roots obtained by subsurface irrigation method. With flat ground cultivation method maximum root length reported in surface method and maximum dry content by without irrigation.

III. CONCLUSION

Micro irrigation techniques have provided an alternative to the farming community because of its water saving and yield increasing potential which raises the prospect of increasing the crop productivity. It has materialized the concept of 'more crop per drop' by insuring the availability of adequate quantity and quality of water especially in dryland agriculture where water is the most limiting factor in crop production. Subsurface drip is expected to give valuable results under dry weather conditions and mitigate the adverse effect of water scarcity supporting substantially good yield. Fertigation is also an advance technique which saves 20-40% fertilizers and 40-50% water saving as well as nutrient uptake and better quality of produce.

Application of research: Beneficial to farmer and improve soil health as well as save water.

Research category: Role of micro-irrigation in vegetable crops.

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