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IRRIGATION IN CITRUS ORCHARDS**

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MANAGING WATER AND NUTRIENTS THROUGH DRIP IRRIGATION IN CITRUS ORCHARDS

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INTRODUCTION

Citrus is the third important fruit crop after banana and mango in India. Irrigation water scarcity is one of the major causes of low productivity and declining of citrus orchards in India. The crop is basically irrigated through conventional basin and furrow irrigation method using ground water in the citrus belts. The non-scientific irrigation scheduling and faulty method of irrigation invites the water scarcity in summer, resulting in drying of orchards each year. Thus, optimal irrigation scheduling through efficient irrigation system such as micro-irrigation is utmost essential in citrus grown areas of the country.

Along with water, nutrients are also essential for sustainable citrus production. As a perennial evergreen tree crop, citrus require substantial nutrients in its life cycle. Combined use of irrigation and fertilizers, called fertigation is considered as an effective way for raising the productivity level of citrus orchards due to improved fertilizer use efficiency under micro irrigation. This is only

possible through standardization of fertigation requirement using micro irrigation system. Thus, an efficient irrigation and fertigation programme targets the following aspects:

- Amount of water to meet evapotranspiration (ET) demand of trees
- Time of application
- Method of application
- Reduction of losses through runoff, evaporation, and seepage
- Combining fertilizer application with appropriate frequency of irrigation water

IRRIGATION METHODS

Citrus is generally irrigated by surface methods or micro irrigation (drip, micro-jet) systems. In India, almost all the citrus orchards are irrigated by surface methods e.g. flood, furrow, basin and check systems, which is shaping as a big potential threat to assured water availability for citrus industry of the country in the coming years.

SURFACE IRRIGATION METHODS

Basin irrigation system: It is a most conventional system of irrigation used in citrus orchards. The shape of the basins is circular or rectangular. Its size varies with the horizontal root coverage due to perimeter of trees increasing consistently with age of the plants. To avoid the direct contact of water tree trunk, a gentle slope from the trunk



Figure 1. Double Ring Irrigation-with hose pipe

towards the basin periphery is made. These basins are connected to the irrigation channels / furrows running in between the trees. Some citrus growers also follow double ring method (Fig.1) to avoid the tree union coming in contact with water. In double ring method, the irrigation water is generally applied in between the two rings, so that standing water makes no direct contact with tree trunk. Irrigation through hose pipe in double ring method enhances the conveyance capacity of water and hence, aides to water use efficiency.

Flood irrigation: Basin irrigation is replaced by flood irrigation when the trees are fully grown. This irrigation system is applicable only when ground is level. It is undoubtedly a system not so effective with regard to water economy, fertilizer use and sustainable productivity of citrus orchards in the long run.

DRIP IRRIGATION SYSTEM

Drip irrigation is a method which optimizes the effective use of irrigation water through uniform distribution and its application to the root zone of the plants through a closed network of plastic pipes and emitters/ drippers. The basic principle involved in drip irrigation is frequent application of water as per the plant requirement to meet its evapo-transpiration requirement at low discharge rate (drop by drop) directly to root zone. The soil moisture held under the drippers is at optimum level that favors better nutrient and water uptake. Drip-irrigation has a many advantages over surface irrigation methods.

Merits of drip-irrigation system: Drip or micro irrigation systems hold following advantages over conventional method of irrigation:

- Water saving up to 40-45 % over basin irrigation method.

- Yield increases around 55-60 % over basin method with improved benefit: cost ratio.
- Weed reduction by 40-50 %, thereby reduce the labour cost on weeding.
- Saline water for irrigation can be safely used.
- Equally effective on undulating land used for citrus cultivation
- Enhances better crop growth.
- Prevents soil erosion and runoff under surface irrigation.

With these advantages, the adoption and installation of drip system is economical in citrus orchards with Benefit : Cost = 2.1

Essential components drip-irrigation system: Following are the essential components of drip irrigation system:

- Water source: well, tube well, canals, river, pond, etc.
- Electrical pump: mono block or sub-mercible
- Filters: sand, screen and by - pass arrangement
- Back wash arrangement and pressure gauges
- Fertilizer tank/injection tank/venturi
- Main pipe line and control valves
- Laterals (12, 16, 20, 25 mm)
- Drippers (4, 8, 16 liter per hour)

Installation and maintenance of drip irrigation system

Precautions before/during drip installation: Before installation of drip irrigation systems, the following points should be considered for smooth installation and operation of the system:

- Soil physico-chemical analysis of orchard and water analysis of water source



- Sand and screen filters for water containing debris, algae etc.
- Main and sub-mains of PVC to be installed at 1.5 to 2.00 feet below ground.
- If the land has slope, then sub-main should be laid along with slope and lateral across the slope.
- Design should be done as per the slope, orchard land topography and plant requirement.
- In drip system for 12 mm diameter lateral, 40-50 m long lateral and for 16 mm diameter, 60-70 m long lateral in field should be usually used.
- Drippers should be installed on upper side of the slope and at the convenient distance as per the plant age.

Maintenance of drip-irrigation system:

After successful installation of the micro irrigation system, maintenance of the system is a vital component, which requires sufficient technical knowledge to cope up. The following points should be kept in mind for better maintenance of the system:

- Laterals and sub-main pipe lines should be flushed at least once in a week keeping the system at 1.5 to 2.0 kg/cm² operating pressure.
- Regular checking of the drippers for operation, breakups or some leakages.
- Clogged drippers should be treated in acid (12N HCl) at least once in six months.
- Laterals of the drip system should be rolled and kept inside the safe place during the rainy period.
- Chlorination (calcium hypochloride solution at 45 g/l) should be done as per requirement or once in 6 months.
- Cleaning of screen filter and sand filter once in a week or as and when required.

IRRIGATION SCHEDULING AND WATER REQUIREMENT

The amount of water to be applied on daily basis (water requirement) is an integral part of an efficient micro-irrigation scheduling. Maintaining soil moisture at optimum level during the critical growth period through proper irrigation scheduling is essential for sustainable citrus production. Irrigation scheduling at different level of soil moisture depletion viz., 10%, 20%, 30% and 40% indicated the best growth, fruit yield and quality under drip irrigation at 20% depletion of soil moisture in citrus grown on black clay soils of central India. Response of irrigation scheduling based on open pan evaporation (0.6, 0.7, 0.8 and 0.9 Epan) through drip irrigation system showed the substantial improvement in growth, yield and fruit quality with irrigation at 0.8 of open pan evaporation in citrus on black clay soils of central India.

Frequency of irrigation assumes greater significance in maintaining the plant growth and orchard productivity on sustained basis. The interval may vary 10 to 15 days in winter and 7 to 10 days in summer days under double ring irrigation method. Irrigation during harvest period should be avoided because it reduces total soluble solids and acid. Under central India condition, 28-30 irrigations is sufficient for proper growth and productivity in surface method of irrigation in citrus. In drip/microjet irrigation the irrigation interval is 2-3 days in clay soils and daily for sandy soils

The formula of 'ABCDE' is usually used for computing the water requirement where, A – Area of the plant (6m x 6m = 36 m² for Nagpur mandarin), B – Pan Evaporation Factor (0.6 in winter and 0.8 in summer) take average 0.7, C – Crop Factor (0.6 for citrus), D – Wetting factor (0.2 to 1.00 up to full growth) and

Month	Age of the plant (year)									
	1	2	3	4	5	6	7	8	9	10 & above
Jan.	7	15	22	30	44	62	72	82	92	102
Feb.	9	20	30	40	60	82	96	108	121	137
Mar.	12	26	40	53	78	109	127	145	163	181
Apr.	14	29	43	63	87	123	143	163	183	204
May	17	34	52	74	102	143	166	188	211	235
Jun.	11	22	34	48	67	95	110	126	142	157
Oct.	9	17	27	40	52	79	92	105	118	131
Nov.	8	15	25	36	45	63	74	85	96	105
Dec.	6	11	19	24	35	49	57	65	73	82

E – USWB pan-evaporation, mm per day

$$\text{Water requirement (litres/day/plant)} = A \times B \times C \times D \times E.$$

WATER REQUIREMENT (LITRES/DAY/PLANT) OF CITRUS:

The water requirement computed for different plant age has been worked out to vary from 2,790 litre / year / plant for 1-year-old plants to 40,000 litre/ year/ plant for 10-year-old plants in central India.

DRIPPERS NUMBER AND POSITION:

Following the details about the number of drippers per plant to be placed at a distance from tree trunk in relation to plant age

Plant age (year)	Number of dripper (4 l/h capacity)	Distance of dripper from tree trunk (m)
1-2	1	0.3
3-4	2	0.45
≥ 5	4	0.75

4. FERTIGATION

Fertigation is a process of application of fertilizers through irrigation water. Under fertigation, water soluble or liquid fertilizers are applied through irrigation on weekly/monthly basis. The basic objective of

fertigation is to supply water and nutrients on each and every plant, regularly and uniformly. Use of proper quantity of fertilizer at appropriate time can be achieved through fertigation. With the adoption of the micro irrigation system, the fertilization schedule in citrus orchards can be adjusted to precise fertilizer application using fertigation technology. In the areas characterized by scarce water resource and insufficient rainfall, fertigation offers the best and sometimes the only alternative of ensuring the nutrients entering the root zone.

ADVANTAGES OF FERTIGATION:

Following are the advantages of fertigation:

- Accurate amount of fertilizer through micro-irrigation saves time, labour, and energy
- Required amount of fertilizer are applied in the effective root zone of the plants. Thus it saves 25 to 30% fertilizers, besides increasing the fruit yield by 15-20 %.
- Fertilizers are applied in diluted form hence it eliminates the danger of burning the plants root system due to dilution effect.
- Other chemicals such as insecticides and weedicides may also be applied along with fertilizers. Thus saving the time and labour further.

- It is possible to apply fertilizer according to crop growth stage and climatic conditions

FERTIGATION IN CITRUS

Fertigation methods: Fertilizer application through micro irrigation method can be done by any of the following methods:

- Through fertilizer tank
- Through venturi
- Through injection pump (dispenser)



Fertilizers used in fertigation

Nitrogen (N)

1. Urea (46:0:0)
2. Urea phosphate (18:44:0)
3. Calcium ammonium nitrate (15:0:0)
Ca-19 %

Phosphorous (P)

1. Urea phosphate (18:44:0)
2. Phosphoric acid (0:86:0)

Potassium (K)

1. Murate of potash (0:0:60)
2. Potassium nitrate (13:0:46)
3. Potassium sulphate (0:0:50)
4. Mono potassium phosphate (0:52:34)

Micro-nutrients (Zn, Fe, Cu, Mn and Bo etc.)

Chelated forms of these micro-nutrients as per need

Fertigation schedule of NPK fertilizers for bearing citrus plant: Following fertigation schedule for citrus has been worked out representing sub-humid tropical climate of central India

Month	Date	N (g/plant)	P ₂ O ₅ (g/plant)	K ₂ O (g/plant)
October	1 st	27.77	-	-
	16 th	27.77	-	-
November	1 st	27.77	-	-
	16 th	27.77	-	-
December	1 st	27.77	-	-
	16 th	27.77	-	-
January	1 st	27.77	-	-
	16 th	27.77	-	-
February	1 st	27.77	15.0	15.0
	16 th	27.77	15.0	15.0
March	1 st	27.77	15.0	15.0
	16 th	27.77	15.0	15.0
April	1 st	27.77	15.0	15.0
	16 th	27.77	15.0	15.0
May	1 st	27.77	15.0	15.0
	16 th	27.77	15.0	15.0
June	1 st	27.77	15.0	15.0
	16 th	27.77	15.0	15.0
Total		500	150	150



4. CONCLUSION

Assured irrigation through efficient and scientific water management during dry season extending from the month of October to May coinciding with critical growth stages of citrus is vital. Application of fertilizers through drip irrigation also ensures the higher water user efficiency and fertilizer use efficiency in citrus cultivation. Thus, integrated application of optimal amount water and fertilizer through drip irrigation is advisable for sustainable and quality citrus production in different regions of the country.

