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## Identification of critical stage of water requirement in acid lime (*Citrus aurantifolia* Swingle) under Western Maharashtra cv. Phule Sharbati

**PS Pawar, NR Dalal and BR Bhite**

### Abstract

A field experiment on identification of critical stage of water requirement in acid lime (*Citrus aurantifolia* Swingle) under Western Maharashtra cv. Phule Sharbati was carried out at All India Coordinated Research Project on Fruits, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri during the period 2014-15 to 2018-19. The results obtained that the effect of different levels of irrigation at different stages on growth, yield and fruit quality of acid lime were significant. The maximum plant height (3.00 m), canopy volume (21.08 m<sup>3</sup>), fruit weight (47.16 g), number of fruits (799.12 fruits/tree), fruit yield (38.01 kg/tree and 10.52 t/ha), juice content (48.64%), acidity (6.70%), ascorbic acid (33.85 mg/100 ml juice) and B:C ratio (1.54) were recorded in the treatment T<sub>7</sub> i. e. application of irrigation water at 80:80:80:80:80:80 ER % from stage-I (January-February) to stage-VI (November-December). From the results, it is recommended that irrigation at 80% evaporation through drip for all growing period (January-December) is better for growth, yield and quality fruits with efficient utilization of irrigation water in acid lime under Western Maharashtra condition. Stage-I (January-February) to stage-III (May-June) are recommended as critical stages with respect to irrigation in acid lime for Western Maharashtra.

**Keywords:** Acid lime, drip irrigation, growth, yield, fruit quality, benefit:cost ratio

### Introduction

Acid lime (*Citrus aurantifolia* Swingle) is mainly grown in semi-arid climate of Maharashtra and adjoining states like Andhra Pradesh, Telangana, Karnataka and Gujarat in central India. The productivity of acid lime is very low (< 5-7 t/ha) because of surface gravity method of irrigation, poor soil-water-air equilibrium and soil application of fertilizers with micro-nutrient deficiencies [5]. Irrigation scheduling based on daily pan evaporation is the essential component affecting growth, yield and fruit quality mainly dependent on the constant and adequate supply of soil moisture in feeder root zone right from fruit set to fruit maturity of acid lime [16, 13]. Acid lime being a perennial evergreen tree requires soil moisture and all required nutrients for higher orchard efficiency during the fruit growth stages. The inadequate moisture in critical stages of the crop hampers the fruit yield and quality drastically [4]. Acid lime is one of the important citrus fruit crop grown in India on an area of 2,40,000 hectares with total production of 25,55,000 MT and productivity of 10.64 MT/ha [1]. The objective of this investigation was to identify the critical stage of water requirement and also to study the effect of different levels of irrigation schedules based on evaporation replenishment (ER) at different growth stages on plant growth, yield, fruit quality and economics of bearing acid lime grown in Western Maharashtra condition.

### Material and Methods

The experiment was conducted at All India Coordinated Research Project on Fruits, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri during the period of 2014-15 to 2018-19. The statistical design applied for the experiment was Randomized Block Design (RBD) with seven treatments replicated four times. The trees of acid lime cv. Phule Sharbati was planted in medium black soil at a distance of 6 x 6 m. Nine years old uniform acid lime trees were selected for the experiment. Four trees were used for each treatment. Observations of growth, yield and fruit quality were recorded. The data was statistically analyzed following the standard procedure given by Panse and Sukhatme [8].

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## Treatment details

Treatment	Stage -I (Jan-Feb)	Stage -II (Mar-April)	Stage -III (May-June)	Stage -IV (July-Aug)	Stage -V (Sept-Oct)	Stage -VI (Nov-Dec)
T <sub>1</sub>	30 ER (%)	80 ER (%)	80 ER (%)	80 ER (%)	80 ER (%)	80 ER (%)
T <sub>2</sub>	80 ER (%)	30 ER (%)	80 ER (%)	80 ER (%)	80 ER (%)	80 ER (%)
T <sub>3</sub>	80 ER (%)	80 ER (%)	30 ER (%)	80 ER (%)	80 ER (%)	80 ER (%)
T <sub>4</sub>	80 ER (%)	80 ER (%)	80 ER (%)	30 ER (%)	80 ER (%)	80 ER (%)
T <sub>5</sub>	80 ER (%)	80 ER (%)	80 ER (%)	80 ER (%)	30 ER (%)	80 ER (%)
T <sub>6</sub>	80 ER (%)	80 ER (%)	80 ER (%)	80 ER (%)	80 ER (%)	30 ER (%)
T <sub>7</sub>	80 ER (%)	80 ER (%)	80 ER (%)	80 ER (%)	80 ER (%)	80 ER (%)

(ER = Evaporation Replenishment)

**Results and Discussion**

The pooled data (2014-15 to 2018-19) depicted in Table 1 revealed that the maximum plant height (3.00 m), canopy volume (21.08 m<sup>3</sup>), fruit weight (47.16 g), number of fruits (799.12 fruits/tree) and yield (38.01 kg/tree and 10.52 t/ha) were recorded in the treatment T<sub>7</sub> i.e. application of irrigation water at 80:80:80:80:80:80 ER % from stage-I (January-February) to stage-VI (November-December) and was at par with the treatment T<sub>6</sub> i. e. application of irrigation water at 80:80:80:80:80:30 ER % from stage-I (January-February) to stage-VI (November-December). The maximum growth and yield by application of irrigation water at 80:80:80:80:80:80 ER % from stage-I (January-February) to stage-VI (November-December) might have been due to its beneficial effects on photosynthesis and dry matter production. Similar increase in growth and yield by application of irrigation water at 80 ER % to all growth stages were reported by Srivastava *et al.* 2003 [17] in Nagpur mandarin, Balaganvi and Kumathe 2004 [2] in acid lime and Shirgure *et al.* 2014 [15] in Nagpur mandarin. There was reduction in growth and yield by application of irrigation water at 30 ER % during stage-I (January-February), stage-II (March-April) and stage-III (May-June) indicated that stage-I (January-February) to stage-III (May-June) are the critical stages of water requirement under drip irrigation in acid lime.

The pooled data (2014-15 to 2018-19) in respect of fruit quality depicted in Table 2 revealed that, the maximum juice content (48.64%), acidity (6.70%) and ascorbic acid (33.85 mg/100 ml juice) were also recorded in treatment T<sub>7</sub> i. e. application of irrigation water at 80:80:80:80:80:80 ER % from stage-I (January-February) to stage-VI (November-December). The application of irrigation water at 80 ER % at all the growth stages enhanced the photosynthetic rate and auxins production which in turn improved the fruit quality of acid lime. This result is in conformity with the findings of

Shirgure *et al.* 2004a [12] in acid lime, Shirgure and Srivastava 2013 [14] in Citrus and Shirgure *et al.* 2014 [15] in Nagpur mandarin. There was non-significant difference between the treatments for TSS, number of seeds/fruit, weight of seeds/fruit and rind thickness.

**Economics**

The economics of various treatments of irrigation levels and at different stages on benefit: cost ratio is shown in Table 3. The treatment T<sub>7</sub> i. e. application of irrigation water at 80:80:80:80:80:80 ER % from stage-I (January-February) to stage-VI (November-December) was found superior and recorded higher benefit: cost ratio (1.54) over rest of the treatments. Similar results were reported by Shirgure *et al.* 2002 [10] in acid lime and Barua and Hazarika 2014 [3] in Assam lemon.

The mean data (2014-15 to 2018-19) presented in Table 4 and 5 indicated the stage wise mean water requirement of acid lime through drip irrigation system in litres/plant/stage and in cm/plant/stage, respectively. The total water applied at different treatments was in the range of 10166.40 litres/plant/stage (28.24 cm/plant/stage) to 12009.60 litres/plant/stage (33.36 cm/plant/stage) in drip method of irrigation i. e. from stage-I (January-February) to stage-VI (November-December). The total water required was less in treatment T<sub>3</sub> i. e. application of irrigation water at 80:80:30:80:80:80 ER % as compared to all other treatments. The quantity of water use was more during the summer months due to low relative humidity and higher temperature and transpiration. Irrigation was not given during rainy period due to lower cumulative pan evaporation than rainfall amount. Similar studies on water use in Citrus crops has been reported by Mageed *et al.* 1988 [7] in Kinnow mandarin, Shirgure *et al.* 2000 [9] and Shirgure *et al.* 2003 [11] in acid lime and Kumar *et al.* 2013 [6] in Sathgudi sweet orange.

**Table 1:** Effect of stage wise application of irrigation water on growth and yield in acid lime (Pooled mean 2014-15 to 2018-19)

Treatment	Plant Height (m)	Canopy volume (m <sup>3</sup> )	Fruit Weight (g)	Number of fruits / tree	Yield (kg/tree)	Yield (t/ha)
T <sub>1</sub>	2.93	19.33	44.21	752.78	33.69	9.32
T <sub>2</sub>	2.87	18.43	41.54	737.56	30.38	8.41
T <sub>3</sub>	2.86	18.25	43.10	748.08	32.35	8.95
T <sub>4</sub>	2.96	20.35	46.01	766.50	35.85	9.92
T <sub>5</sub>	2.97	20.04	45.74	772.80	36.00	9.96
T <sub>6</sub>	2.96	20.65	46.78	790.82	37.37	10.34
T <sub>7</sub>	3.00	21.08	47.16	799.12	38.01	10.52
S. E. ±	0.02	0.50	0.48	3.17	0.86	0.24
C. D. at 5%	0.07	1.47	1.42	9.27	2.52	0.70

**Table 2:** Effect of stage wise application of irrigation water on fruit quality in acid lime (Pooled mean 2014-15 to 2018-19)

Treatment	Juice (%)	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg/100 ml juice)	Number of seeds / fruit	Weight of seeds / fruit (g)	Rind thickness (mm)
T <sub>1</sub>	43.60	6.82	6.60	31.09	8.14	0.64	1.35
T <sub>2</sub>	41.88	6.91	6.45	29.95	8.23	0.66	1.45
T <sub>3</sub>	44.27	6.96	6.49	30.34	8.34	0.64	1.43
T <sub>4</sub>	45.70	7.05	6.40	31.33	8.95	0.64	1.41
T <sub>5</sub>	45.73	7.06	6.62	31.20	8.16	0.57	1.36
T <sub>6</sub>	47.57	7.10	6.68	32.14	8.02	0.62	1.27
T <sub>7</sub>	48.64	7.16	6.70	33.85	7.41	0.56	1.11
S. E. ±	0.79	0.12	0.06	0.60	0.52	0.03	0.12
C. D. at 5%	2.32	NS	0.20	1.77	NS	NS	NS

**Table 3:** Economics on effect of stage wise application of irrigation water in acid lime (2018-19)

Treatment	Total Expenditure (Rs/ha)	Yield (t/ha) Pooled mean	Gross monetary return (Rs/ha)	Net Profit (Rs/ha)	B : C ratio
T <sub>1</sub>	1,64,771=20	9.32	2,33,000=00	68,228=80	1.41
T <sub>2</sub>	1,60,961=38	8.41	2,10,250=00	49,288=62	1.30
T <sub>3</sub>	1,63,209=38	8.95	2,23,750=00	60,540=62	1.37
T <sub>4</sub>	1,67,277=88	9.92	2,48,000=00	80,722=12	1.48
T <sub>5</sub>	1,67,442=55	9.96	2,49,000=00	81,557=45	1.48
T <sub>6</sub>	1,69,025=69	10.34	2,58,500=00	89,474=31	1.52
T <sub>7</sub>	1,69,802=11	10.52	2,63,000=00	93,197=89	<b>1.54</b>

Produce sold @ Rs. 25,000/tonne.

**Table 4:** Stage wise mean water requirement of acid lime through drip irrigation system (litres/plant/stage) (Mean 2014-15 to 2018-19)

Treatment	Stage-I (Jan - Feb)	Stage-II (Mar -April)	Stage-III (May -June)	Stage-IV (July -Aug)	Stage-V (Sept -Oct)	Stage-VI (Nov -Dec)	Total
T <sub>1</sub>	669.60	2833.20	2948.40	1400.40	1515.60	1526.40	10893.60
T <sub>2</sub>	1785.60	1062.00	2948.40	1400.40	1515.60	1526.40	10238.40
T <sub>3</sub>	1785.60	2833.20	1105.20	1400.40	1515.60	1526.40	10166.40
T <sub>4</sub>	1785.60	2833.20	2948.40	525.60	1515.60	1526.40	11134.80
T <sub>5</sub>	1785.60	2833.20	2948.40	1400.40	568.80	1526.40	11062.80
T <sub>6</sub>	1785.60	2833.20	2948.40	1400.40	1515.60	572.40	11055.60
T <sub>7</sub>	1785.60	2833.20	2948.40	1400.40	1515.60	1526.40	12009.60

**Table 5:** Stage wise mean water requirement of acid lime through drip irrigation system (cm/plant/stage) (Mean 2014-15 to 2018-19)

Treatment	Stage-I (Jan - Feb)	Stage-II (Mar -April)	Stage-III (May -June)	Stage-IV (July -Aug)	Stage-V (Sept -Oct)	Stage-VI (Nov -Dec)	Total
T <sub>1</sub>	1.86	7.87	8.19	3.89	4.21	4.24	30.26
T <sub>2</sub>	4.96	2.95	8.19	3.89	4.21	4.24	28.44
T <sub>3</sub>	4.96	7.87	3.07	3.89	4.21	4.24	28.24
T <sub>4</sub>	4.96	7.87	8.19	1.46	4.21	4.24	30.93
T <sub>5</sub>	4.96	7.87	8.19	3.89	1.58	4.24	30.73
T <sub>6</sub>	4.96	7.87	8.19	3.89	4.21	1.59	30.71
T <sub>7</sub>	4.96	7.87	8.19	3.89	4.21	4.24	33.36

## Conclusion

Considering five-year study of the effect of different levels of irrigation at different stages, it was concluded that the treatment T<sub>7</sub> i. e. application of irrigation water at 80:80:80:80:80:80 ER % from stage-I (January-February) to stage-VI (November-December) was found to be superior. Therefore, it is recommended that irrigation at 80% evaporation through drip for all growing period (January-December) is better for growth, yield and quality fruits with efficient utilization of irrigation water in acid lime under Western Maharashtra condition. Stage-I (January-February) to stage-III (May-June) are recommended as critical stages with respect to irrigation in acid lime for Western Maharashtra.

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