

Original Research Article

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Standardization of Drip Irrigation Scheduling for Jasmine (*Jasminum sambac* Ait. cv. Ramanathapuram Gundumalli) using Theta Probe moisture meter

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ABSTRACT

Keywords

Jasmine, moisture depletion percentage, irrigation frequency and flower yield

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An experiment entitled, “Standardization of drip irrigation scheduling for Jasmine (*Jasminum sambac* Ait. cv. Ramanathapuram Gundumalli) using Theta Probe moisture meter” was carried out at Farmer’s holding, Neithalur Colony in Tiruchirappalli District, Tamil Nadu, India from November, 2015 to May, 2016 to standardize the irrigation requirement and irrigation frequency for Jasmine. Factorial randomized block design was employed with three factors each two levels and replicated thrice. The investigation consisted of two levels each on soil depth, moisture depletion percentage and quantity of irrigation water viz., soil depth @ 15 cm and 30 cm, moisture percentage 40 % and 60 % and quantity of irrigation water 15 l and 20 l per plant and flood irrigation (control). The jasmine plants receiving 20 l of irrigation water per plant when moisture depletion percentage reaches 60 % at 30 cm soil depth were performing well in all the growth, yield and agronomic attributes. Hence, it is recommended that, irrigation @ 20 l per plant at 4 day intervals can be adopted for high growth, physiological, yield and agronomic parameters in Jasmine plants.

Introduction

The genus *Jasminum* belongs to the family Oleaceae. Although more than 2,000 species are known, 40 species have been identified in India and 20 are cultivated in South India (Bhattacharjee, 1980) which comprises mainly shrubs and climbers. Jasmine is a fragrance and an important commercial flower crop in tropical and sub-tropical areas of South East Asia and other parts of world. It is also an important source of jasmine concrete and perfume extraction. Jasmine is the national flower of Phillipines, which was adopted in 1937 (Sushma *et al.*, 2015). And,

recently in 1990, Indonesian government also has adopted it as the national flower (Jayamma *et al.*, 2014). Jasmine concrete is now being produced industrially in India and it is a highly profitable venture and the demand is increasing in the world market because of its unique fragrance which cannot be imitated by synthetic chemicals.

The standard soil moisture estimation procedures such as gravimetric and neutron probe methods used were not well suited for portable use in field data collection. Recently,

an impedance probe (Theta Probe, Delta-T Devices, Cambridge UK) has received acceptance for surface soil water content measurements, especially by the remote sensing community (Jacobs *et al.*, 2004). A reliable, rapid technique is needed, and recently an impedance soil moisture probe (Theta Probe) has been accepted by the scientific community. Judicial management of irrigation water can be achieved by using soil moisture sensors like neutron probe and Theta Probe.

Many of the research works has been carried out on responses of jasmine plants to macro and micronutrients, plant growth and irrigation intervals but irrigation based on moisture depletion percentage and evapotranspiration has not been studied. With this above background the present study has been taken to standardize the irrigation requirement and its frequency using Theta Probe moisture meter for jasmine (*Jasminum sambac*).

Materials and Methods

Moisture depletion percentage was estimated in the soil profile 0-15 cm, 15-30 cm and 30-45 cm. The soil moisture depletion was more pronounced in the layer of 15-30 and 30-45 cm. So it was correlated with the evaporation and moisture extraction capacity of the jasmine plants. It was indicated that active plant roots are actively extracting the moisture content present in the layer of 15-45 cm than the layer of 0-15 cm. The moisture content in the top layer 0-15 cm can be easily reduced due to prevailing environment, it was not affected the growth and development of jasmine.

The experiment was conducted at farmer's field, Neithalur Colony, Tiruchirappalli District, Tamil Nadu during last week of November, 2015 to May, 2016. Initial soil-

chemical, physical properties of selected field were: pH 7.8, EC 0.12 d sm⁻¹, N 220 kg ha⁻¹, P 20.1 kg ha⁻¹, K 229 kg ha⁻¹ and bulk density of 1.36 kg m⁻³.

Experiment Details

The trial was laid out in Factorial Randomized Block Design with 8 treatment combinations and replicated thrice. The three factors having 2 levels such as 8 treatment combinations *viz.*, two levels of irrigation water given (15 l and 20 l per plant) when soil moisture depletion reaches 40 % and 60 % at the depth of 15 cm and 30 cm as per the treatment schedule and control (Flood irrigation once in a week). The jasmine bushes were uniformly pruned during last week of November, 2015 and except irrigation all the cultural practices were followed uniformly. The observations on growth, physiological parameters, yield parameters and agronomic parameters were observed and data analysis subjected to LSD at 5 % probability level by Panse and Shukatme (1985).

Factor 1: Depth of soil D₁ 15 cm D₂ 30 cm

Factor 2: Moisture depletion percent M₁ 40 % M₂ 60 %

Factor 3: Water level W₁ 15 l W₂ 20 l per plant

Results and Discussion

With availability of irrigation water dwindling day-by-day, it has become necessary to resort to alternate water saving methods like drip irrigation which provides continuous supply of water in drops right at the root zone of the plant. The scarcity of water is becoming more acute due to erratic and improper distribution of rainfall and faulty water management practices (Bafna *et al.*, 1993).

Growth parameters

The data on the growth parameters showing that the different irrigation regimes were significantly influenced the growth and development of jasmine. Growth in terms of plant height and leaf area at 30, 60, 90, 120, 150 and 180 days after pruning showed significant difference among different irrigation regimes.

Plant height (cm)

Among the different irrigation regimes, the plants receiving 20 litre of irrigation water per plant when soil moisture depletion reaches 60 % at the depth of 30 cm recorded maximum plant height 81.9, 105.8, 120.0, 131.7, 138.4 and 141.6 cm at 30, 60, 90, 120, 150 and 180 days after pruning respectively. This was closely followed by the plants receiving 20 litre of water per plant when soil moisture depletion reaches 60 % at 15 cm depth of soil (78.7, 99.1, 111.0, 121.0, 126.4 and 128.7 cm at 30, 60, 90, 120, 150 and 180 days after pruning respectively). Simultaneously, the flood irrigated plants recorded least values for plant height among the different irrigation regimes (72.0, 79.7, 85.2, 88.4, 89.6 and 90.1 at 30, 60, 90, 120, 150 and 180 days after pruning respectively (Table 1).

The linear trend in plant growth might be due to the fact that optimum irrigations maintained most of the root zone at well aerated condition and at adequate soil moisture content there were no fluctuations between wet and dry extremes (Patil and Janawade, 1999). This findings was corresponding with previous results revealed by Taweesaak *et al.*, 2014. Availability of moisture under drip irrigation might have contributed to effective absorption and utilization of nutrients and better proliferation of roots resulting in better growth. Better soil moisture condition may positively contribute

for higher solubility and mobility of nutrients which ultimately results into increased mass flow transport of nutrients (Tisdale *et al.*, 1997).

Leaf area

Irrigation regime of 20 litre of irrigation water per plant when soil moisture depletion reaches 60 % at the soil depth of 30 cm were recorded highest leaf area of 7.07, 8.14, 9.29, 10.50, 11.82 and 12.84 cm² at 30, 60, 90, 120, 150 and 180 days after pruning respectively. This was closely followed by the plants receiving 20 litre of water per plant when soil moisture depletion reaches 60 % at 15 cm depth of soil (6.87, 7.90, 8.99, 10.16, 10.60 and 12.32 cm² at 30, 60, 90, 120, 150 and 180 days after pruning respectively). The flood irrigated plants recorded least values for leaf area among the different irrigation regimes (6.06, 6.81, 7.53, 7.91, 8.43 and 8.62 cm² at 30, 60, 90, 120, 150 and 180 days after pruning respectively (Table 2). Growth and development in plants are a consequence of excellent coordination of several processes operating at different stages of plant. Reduced irrigation level resulting in water deficit might manifest many changes in plant anatomy such as decrease in size of cells and inter cellular spaces limiting cell division and elongation resulting in overall decrease in plant growth (May and Milthrope, 1962). In the present study the growth of jasmine, as influenced by the various treatments, has been elucidated through plant height and leaf area.

Yield parameters

Earlier flower bud emergence (24.4 days) and earlier flower bud picking (34.2 days) were observed in the treatment receiving optimum irrigation frequency and control (Flood irrigation) taken maximum days for flower bud emergence and flower bud picking (Table 3).

Fig.1 Effects of different irrigation regimes on yield of flower buds per plant of *Jasminum sambac* cv. Ramanathapuram Gundumalli

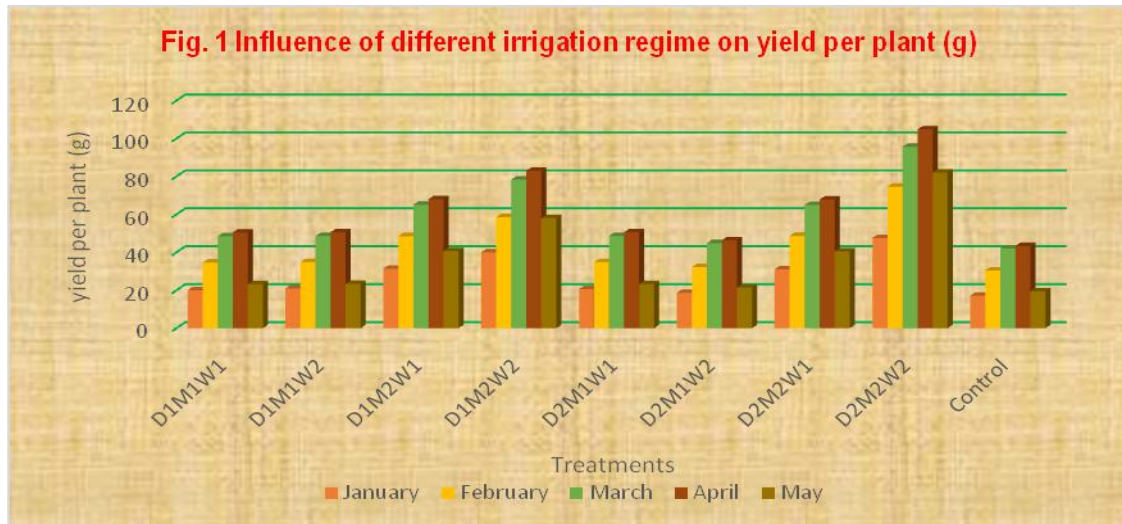
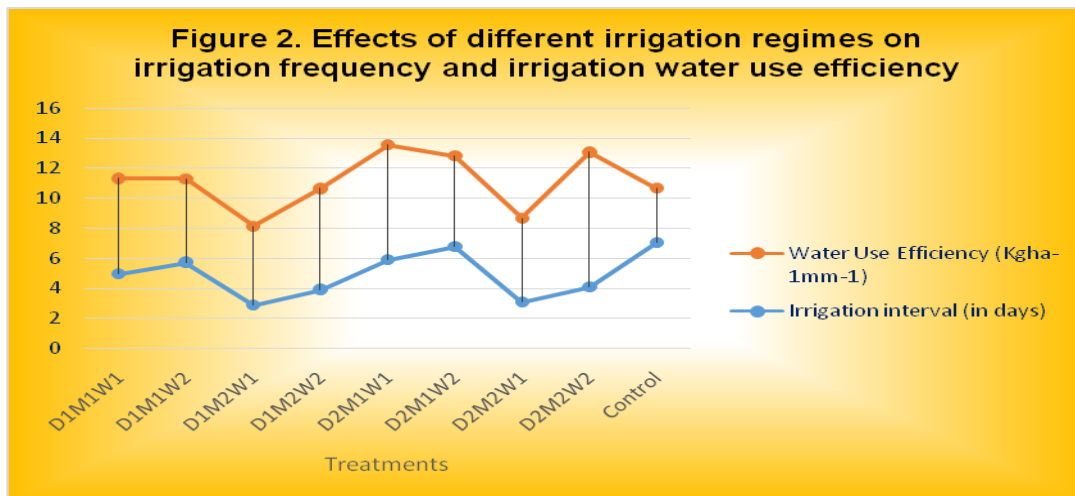


Fig.2 Effects of different irrigation regimes on irrigation frequency and water use efficiency of *Jasminum sambac* cv. Ramanathapuram Gundumalli



Treatment details

- D₁M₁W₁ - Soil depth 15 cm + Moisture depletion 40 % + Water level 15 l per plant
- D₁M₁W₂ - Soil depth 15 cm + Moisture depletion 40 % + Water level 20 l per plant
- D₁M₂W₁ - Soil depth 15 cm + Moisture depletion 60 % + Water level 15 l per plant
- D₁M₂W₂ - Soil depth 15 cm + Moisture depletion 60 % + Water level 20 l per plant
- D₂M₁W₁ - Soil depth 30 cm + Moisture depletion 40 % + Water level 15 l per plant
- D₂M₁W₂ - Soil depth 30 cm + Moisture depletion 40 % + Water level 20 l per plant
- D₂M₂W₁ - Soil depth 30 cm + Moisture depletion 60 % + Water level 15 l per plant
- D₂M₂W₂ - Soil depth 30 cm + Moisture depletion 60 % + Water level 20 l per plant
- Control - Flood irrigation once in a week

Table.1 Effect of different irrigation regime on plant height (cm) of *Jasminum sambac* cv. Ramanathapuram Gundumalli at 30, 60, 90, 120, 150 and 180 days after pruning

Days after pruning	Treatments	D ₁		Mean	D ₂		Mean	W x M		Mean	Control
		W ₁	W ₂		W ₁	W ₂		W ₁	W ₂		
30 DAP	M ₁	74.6	74.7	74.7	74.8	73.6	74.2	74.7	74.2	74.4	72.0
	M ₂	76.8	78.7	77.7	76.9	81.9	79.4	76.9	80.3	78.6	
	Mean	75.7	76.7	76.2	75.9	77.7	76.8	75.8	77.2	76.5	
60 DAP	M ₁	89.6	89.5	89.6	89.4	84.6	87.0	89.5	87.1	88.3	79.7
	M ₂	94.6	99.1	96.8	94.9	105.8	100.3	94.7	102.5	98.6	
	Mean	92.1	94.3	93.2	92.1	95.2	93.7	92.1	94.8	93.4	
90 DAP	M ₁	98.1	97.9	98.0	97.6	91.7	94.7	97.8	94.8	96.3	85.2
	M ₂	104.7	111.0	107.8	104.6	120.0	112.3	104.7	115.5	110.1	
	Mean	101.4	104.4	102.9	101.1	105.9	103.5	101.2	105.1	103.2	
120 DAP	M ₁	104.0	103.8	103.9	103.7	96.6	100.2	103.9	100.2	102.1	88.4
	M ₂	111.9	121.0	116.5	111.8	131.7	121.8	111.9	126.4	119.1	
	Mean	108.0	112.4	110.2	107.8	114.2	111.0	107.9	113.3	110.6	
150 DAP	M ₁	107.0	106.7	106.9	106.7	98.3	102.5	106.9	102.5	104.7	89.6
	M ₂	116.2	126.4	121.3	116.0	138.4	127.2	116.1	132.4	124.3	
	Mean	111.6	116.6	114.1	111.4	118.3	114.9	111.5	117.5	114.5	
180 DAP	M ₁	107.8	107.4	107.6	107.3	99.1	103.2	107.5	103.2	105.4	90.1
	M ₂	117.3	128.7	123.0	117.2	141.6	129.4	117.2	135.2	126.2	
	Mean	112.5	118.1	115.3	112.2	120.3	116.3	112.4	119.2	115.8	

		D	M	W	DM	MW	DW	DMW
30 DAP	SEd	0.1005	0.1005	0.1005	0.1422	0.1422	0.1422	0.2011
	CD @ 0.05	0.2157	0.2157	0.2157	0.3051	0.3051	0.3051	0.4315
60 DAP	SEd	NS	0.2463	0.2463	0.3484	0.3484	NS	0.4927
	CD @ 0.05	NS	0.5285	0.5285	0.7474	0.7474	NS	1.0569
90 DAP	SEd	0.1488	0.1488	0.1488	0.2104	0.2104	0.2104	0.2976
	CD @ 0.05	0.3192	0.3192	0.3192	0.4515	0.4515	0.4515	0.6385
120 DAP	SEd	NS	0.4351	0.4351	0.6154	0.6154	0.6154	0.8703
	CD @ 0.05	NS	0.9334	0.9334	1.3201	1.3201	1.3201	1.8669
150 DAP	SEd	0.2844	0.2844	0.2844	0.4022	0.4022	0.4022	0.5688
	CD @ 0.05	0.6101	0.6101	0.6101	0.8628	0.8628	0.8628	1.2202
180 DAP	SEd	0.4362	0.4362	0.4362	0.6169	0.6169	0.6169	0.8724
	CD @ 0.05	0.9357	0.9357	0.9357	1.3232	1.3232	1.3232	1.8714

Table.2 Effect of different irrigation regime on leaf area (cm²) of *Jasminum sambac* cv. Ramanathapuram Gundumalli at 30, 60, 90, 120, 150 and 180 days after pruning

Days after pruning	Treatments	D ₁		Mean	D ₂		Mean	W x M		Mean	Control
		W ₁	W ₂		W ₁	W ₂		W ₁	W ₂		
30 DAP	M ₁	6.41	6.42	6.41	6.42	6.21	6.31	6.41	6.31	6.36	6.06
	M ₂	6.71	6.87	6.79	6.69	7.07	6.88	6.70	6.97	6.84	
	Mean	6.56	6.65	6.60	6.56	6.64	6.60	6.56	6.64	6.60	
60 DAP	M ₁	7.19	7.18	7.19	7.18	6.97	7.08	7.19	7.08	7.13	6.81
	M ₂	7.63	7.90	7.76	7.62	8.14	7.88	7.62	8.02	7.82	
	Mean	7.41	7.54	7.48	7.40	7.56	7.48	7.41	7.55	7.48	
90 DAP	M ₁	8.05	8.04	8.05	8.04	7.74	7.89	8.05	7.89	7.97	7.53
	M ₂	8.61	8.99	8.80	8.61	9.29	8.95	8.61	9.14	8.88	
	Mean	8.33	8.52	8.42	8.33	8.51	8.42	8.33	8.52	8.42	
120 DAP	M ₁	8.94	8.95	8.94	8.94	8.15	8.54	8.94	8.55	8.74	7.91
	M ₂	9.65	10.16	9.91	9.63	10.50	10.06	9.64	10.33	9.98	
	Mean	9.29	9.56	9.42	9.28	9.32	9.30	9.29	9.44	9.36	
150 DAP	M ₁	9.85	9.82	9.83	9.83	8.63	9.23	9.84	9.22	9.53	8.43
	M ₂	10.73	11.38	11.06	10.72	11.82	11.27	10.72	11.60	11.16	
	Mean	10.29	10.60	10.44	10.27	10.23	10.25	10.28	10.41	10.35	
180 DAP	M ₁	10.32	10.32	10.32	10.32	8.98	9.65	10.32	9.65	9.99	8.62
	M ₂	11.35	12.32	11.84	11.33	12.84	12.09	11.34	12.58	11.96	
	Mean	10.84	11.32	11.08	10.83	10.91	10.87	10.83	11.12	10.97	

		D	M	W	DM	MW	DW	DMW
30 DAP	SEd	0.0121	0.0121	0.0121	0.0171	0.0171	0.0171	0.0242
	CD @ 0.05	0.0260	0.0260	0.0260	0.0368	0.0368	0.0368	0.0368
60 DAP	SEd	0.0200	0.0200	0.0200	0.0283	0.0283	0.0283	0.0400
	CD @ 0.05	0.0429	0.0429	0.0429	0.0607	0.0607	0.0607	0.0859
90 DAP	SEd	0.0145	0.0145	0.0145	0.0205	0.0205	0.0205	0.0290
	CD @ 0.05	0.0311	0.0311	0.0311	0.0441	0.0441	0.0441	0.0623
120 DAP	SEd	0.0319	0.0319	0.0319	0.0451	0.0451	0.0451	0.0638
	CD @ 0.05	0.0684	0.0684	0.0684	0.0967	0.0967	0.0967	0.1368
150 DAP	SEd	0.0271	0.0271	0.0271	0.0384	0.0384	0.0384	0.0543
	CD @ 0.05	0.0582	0.0582	0.0582	0.0824	0.0824	0.0824	0.1165
180 DAP	SEd	0.0302	0.0302	0.0302	0.0428	0.0428	0.0428	0.0605
	CD @ 0.05	0.0649	0.0649	0.0649	0.0918	0.0918	0.0918	0.1298

Table.3 Effect of different irrigation regime on number days taken for flower bud emergence and first harvesting of *Jasminum sambac* cv. Ramanathapuram Gundumalli

Parameter	Treatments	D ₁		Mean	D ₂		Mean	W x M		Mean	Control
		W ₁	W ₂		W ₁	W ₂		W ₁	W ₂		
Number days taken for flower bud emergence	M ₁	37.7	37.8	37.8	37.7	39.3	38.5	37.7	38.6	38.1	39.9
	M ₂	31.8	28.5	30.2	31.9	24.4	28.1	31.9	26.4	29.1	
	Mean	34.8	33.2	34.0	34.8	31.8	33.3	34.8	32.5	33.6	
Number days taken for first harvesting	M ₁	50.3	50.4	50.4	50.4	52.4	51.4	50.4	51.4	50.9	53.4
	M ₂	43.7	39.3	41.5	43.8	34.2	39.0	43.7	36.7	40.2	
	Mean	47.0	44.8	45.9	47.1	43.3	45.2	47.0	44.1	45.6	

		D	M	W	DM	MW	DW	DMW
Number days taken for flower bud emergence	SEd	0.1410	0.1410	0.1410	0.1994	0.1994	0.1994	0.2820
	CD @ 0.05	0.3025	0.3025	0.3025	0.4278	0.4278	0.4278	0.6050
Number days taken for first harvesting	SEd	0.1397	0.1397	0.1397	0.1976	0.1976	0.1976	0.2795
	CD @ 0.05	0.2997	0.2997	0.2997	0.4239	0.4239	0.4239	0.5995

Table.4 Effect of different irrigation regime on yield per plant of *Jasminum sambac* cv. Ramanathapuram Gundumalli during January, February and March

Period	Treatments	D ₁		Mean	D ₂		Mean	W x M		Mean	Control
		W ₁	W ₂		W ₁	W ₂		W ₁	W ₂		
31 – 60 DAP (January)	M ₁	20.06	20.95	20.51	20.62	18.72	19.67	20.34	19.84	20.09	17.15
	M ₂	31.40	39.98	35.69	31.05	49.70	40.38	31.23	44.84	38.03	
	Mean	25.73	30.47	28.10	25.84	34.21	30.02	25.78	32.34	29.06	
61 – 90 DAP (February)	M ₁	34.63	34.88	34.76	34.81	32.26	33.54	34.72	33.57	34.15	30.49
	M ₂	48.53	58.61	53.57	48.68	74.54	61.61	48.61	66.58	57.59	
	Mean	41.58	46.75	44.16	41.75	53.40	47.57	41.66	50.07	45.87	
90 – 120 DAP (March)	M ₁	48.45	48.60	48.53	48.61	44.86	46.74	48.53	46.73	47.63	42.01
	M ₂	65.18	78.37	71.78	64.97	95.66	80.32	65.08	87.02	76.05	
	Mean	56.82	63.49	60.15	56.79	70.26	63.53	56.80	66.87	61.84	
121 – 150 DAP (April)	M ₁	50.46	50.65	50.56	50.60	46.36	48.48	50.53	48.51	49.52	43.34
	M ₂	68.03	82.99	75.51	67.84	104.84	86.34	67.94	93.92	80.93	
	Mean	59.25	66.82	63.03	59.22	75.60	67.41	59.23	71.21	65.22	
151 – 180 DAP (May)	M ₁	23.25	23.45	23.35	23.29	21.35	22.32	23.27	22.40	22.84	19.46
	M ₂	40.68	58.03	49.36	40.56	82.08	61.32	40.62	70.06	55.34	
	Mean	31.97	40.74	36.35	31.93	51.72	41.82	31.95	46.23	39.09	

		D	M	W	DM	MW	DW	DMW
31 – 60 DAP (January)	SEd	0.2802	0.2802	0.2802	0.3963	0.3963	0.3963	0.5605
	CD @ 0.05	0.6011	0.6011	0.6011	0.8502	0.8502	0.8502	1.2023
61 – 90 DAP (February)	SEd	0.5761	0.5761	0.5761	0.8148	0.8148	0.8148	1.1523
	CD @ 0.05	1.2358	1.2358	1.2358	1.7477	1.7477	1.7477	2.4717
90 – 120 DAP (March)	SEd	0.6902	0.6902	0.6902	0.9761	0.9761	0.9761	1.3804
	CD @ 0.05	1.4805	1.4805	1.4805	2.0937	2.0937	2.0937	2.9610
121 – 150 DAP (April)	SEd	0.3976	0.3976	0.3976	0.5623	0.5623	0.5623	0.7952
	CD @ 0.05	0.8529	0.8529	0.8529	1.2062	1.2062	1.2062	1.7058
151 – 180 DAP (May)	SEd	0.4568	0.4568	0.4568	0.6461	0.6461	0.6461	0.9137
	CD @ 0.05	0.9800	0.9800	0.9800	1.3859	1.3859	1.3859	1.9600

It could be due to the fact that, optimum irrigation and pruning helps to broaden the C/N ratio, thus stimulating flowering and increasing vigour of plant. These results are in line with the findings of Jadhav *et al.*, (2003) and Ghulam *et al.*, (2004) in rose.

Data on flower yield per plant are presented in Table 4 and Figure 1. The maximum yield (49.70, 74.54, 95.66, 104.84 and 82.08 g) per plant was recorded by the treatment receiving 20 l of irrigation water when moisture depletion reaches 60 % at 30 cm depth. The lowest yield of 17.15, 30.49, 42.01, 43.34 and 19.46g per plant was recorded by flood irrigation (Control) during the month of January 2016, February 2016, March 2016, April 2016 and May 2016 respectively.

This might be attributed to effective utilization of root zone irrigation and fertilizer. Irrigation scheduling based on developmental stage or deficit irrigation is the technique of applying water on a timely and accurate basis to the crop, and is the key to conserving water and improving irrigation performance and sustainability of irrigated agriculture (Mpelasoka *et al.*, 2001).

Behboudian and Mills (1997) defined deficit irrigation as applying less water to the plant at selected stages during the growing season. This approach may save water with little or no negative impact on the final crop yield.

Irrigation frequency and Irrigation Water use efficiency

From the statistical analysis, the optimum irrigation frequency was 4 days interval and maximum water use efficiency (8.99 kg ha⁻¹ mm⁻¹) recorded by the plants receiving 20 litre of irrigation water per plant when moisture depletion percentage reaches 60% at the soil depth of 30 cm with maximum value for all the yield contributing attributes. The

least water use efficiency was recorded by control treatment (3.63 kg ha⁻¹ mm⁻¹). Saving of irrigation water was found in all drip irrigation regimes than plants receiving flood irrigation (Figure 2).

Similar findings on water saving by drip irrigation were reported by Ahluwalia *et al.*, (1993); Bafna *et al.*, (1993b); Pawar *et al.*, (1993) and Ramesh *et al.*, (1994).

During the period of experiment, there was a temperature range between 29.2 to 41.3°C and evaporation between the ranges of 1.5 to 4.1 cm. The irrigation water efficiently utilized by the plants which receiving optimum irrigation frequency.

The results obtain from this experiment were showed that optimum irrigation frequency resulted in highest plant growth and flower yield as well as water use efficiency.

The very low and higher irrigation frequency resulted lower yield. This was accorded with study one in gerbera, in which flowering was not influenced by the very low irrigation frequency (Tsirogiannis, 2010).

In the present work different irrigation regimes were tried to standardize the drip irrigation scheduling. Results from this experiment demonstrated that the plants receiving 20 l of irrigation when soil moisture depletion reaches 60 % at 30 cm soil depth can improve the vegetative and flowering characteristics. This treatment were recorded optimum irrigation frequency (4 days interval). This may be attributable to availability of sufficient moisture for better growth and yield of *Jasminum sambac*.

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