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Studies on Water Requirement During Early Growth Stages of Ber Through Drip Irrigation*

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Abstract: Field experiment was conducted for two years in Northern Dry zone of Karnataka to work out the water requirement of ber through drip irrigation. Treatment combinations of wetted area (20,40,60 and 80%) and pan evaporation (25,50 and 75%) were compared with surface irrigation and rainfed control. The mean fruit yield of ber was increased by 3.20 times with surface irrigation and 2.86 to 4.05 times under various drip irrigation treatments over rainfed control (8.0q/ha). Scheduling of irrigation through drip as per T_3 (60%WA X 25% PE or 20% WA X 75% PE) was found optimum with significantly higher fruit yield (30.2 q/ha), saving in water (61.5 to 66.2%) over surface irrigation. The highest water-use-efficiency (1.33 and 3.82 q/ha-cm) was also recorded in this treatment. The main stem girth, canopy coverage and canopy volume of ber tree during its early growth stages were significantly influenced due to various water application rates through drip irrigation.

Introduction

Dryland orchard crops are considered to perform better with restricted availability of rainwater or irrigation. Ber is one such fruit crop which has low water requirement as such well suited for arid and semi-arid regions. Though ber is known as hardy plant its productivity is reported to be many times higher under irrigated conditions (Pareek, 1983). However, information on exact quantity of water needed by ber plant is scanty. The bulk of ber area in Karnataka is concentrated in Northern Dry Zone (72%). Further, about 43 per cent of the total area under bore well and open well irrigation of the state is in this zone. Drip irrigation system is readily suited for this type of irrigation. It has been estimated that the area under drip irrigation is steadily increasing over the years. However, information about scientific scheduling of irrigation water through drip to some of the dryland horticultural crops is very much lacking. Considering the above, studies were conducted to determine the water requirement of ber during its early growth stages through drip irrigation system.

Material and Methods

Field experiment was conducted at Water Management Research Centre, Belvatagi located in the Northern Dry Zone of Karnataka during 1994-95 and 1995-96. There were eight drip irrigation treatments of water application rates based on the combinations of per cent wetted area (20,40,60 and 80) and per cent pan evaporation (25,50 and 75). These treatments were compared with surface irrigation and rainfed control. The treatments were replicated five times in a randomised block design. The ber trees were established in October, 1992 with 6m x6m spacing and received all recommended cultural practices. The ber trees were pruned in April 1994 and from June 1994 irrigation treatments were imposed daily. The quantity of water applied was worked out for each treatment based on the equation (Atul Chandra, 1993) as given below.

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Quantity of water = Plant spacing(m^2) XWetted area (%) X
(Litre/day/tree) Pan evaporation (mm/day) X Pan evaporation (%)

The quantity of water applied in each treatment during both the years are presented in table 1. Drip irrigations were given between the months of June to January for totally 147 and 152 days during 1994-95 and 1995-96, respectively. The total rainfall of 465.1 and 585.o mm was received during 1994-95 and 1995-96, respectively The main stem girth of ber tree was measured at 0.5m above ground level at the beginning of season, fruit development and pruning. Shaded area of ber tree was measured during flowering and fruiting stages at noon. The volume of tree was calculated as suggested by Wutscher and Shull (1972). The ber fruits were harvested as and when matured.

Results and Discussion

The main Stem girth of ber under all drip and surface irrigation treatments was significantly higher compared to rainfed control during all the growth stages in both the years (Table 2). Among drip irrigation treatments T_3 recorded the highest main stem girth of 19.14 cm at fruit development and pruning stage during 1994-95 which was on par with all other drip irrigated treatments except T_1 at fruit development stage. During 1995-96, T_4 recorded the highest girth of 22.52, 29.32 and 31.38 cm at the beginning of season, fruiting and pruning stages, respectively. The cumulative per cent increase in girth of main stem over first observation during all growth stages was highest in drip irrigated treatments followed by surface irrigation and rainfed control. There were significant variations in canopy canopy coverage of ber tree at flowering initiation and fruit harvest stage during both the years due to different treatments (Table 3). The lowest canopy coverage of 2.19 and 4.47 sq.m per tree during 1994-95 and 8.63 and 17.73 sq. m per tree during 1995-96 were recorded in rained control at flower initiation and fruit harvest stages, respectively. The percentage of area covered by canopy to the total trees space allotted (36 sq.m) indicated that it increased progressively

Table 1. Details of treatments and total quantity of water appplied per tree

Treatments	Total quantity of water applied(Litres/tree)	
	1994-95	1995-96
T_1 :20% WA X 25% PE	1255	1467
T_2 :40% WA X 25% PE or 20% WA X 50% PE	2509	2934
T_3 :60% WA X 25% PE or 20% WA X 75% PE	3764	4401
T_4 :40% WA X 50% PE or 80% WA X 25% PE	5018	5868
T_5 :40% WA X 75% PE or 60% WA X 50% PE	7528	8802
T_6 :80% WA X 50% PE	10037	11736
T_7 :60% WA X 75% PE	11291	13203
T_8 :80% WA X 75% PE	15055	17604
T_9 :Surface irrigation*	9705	12960
T_{10}:Rainfed control	-	-

*Check basin method, scheduled at 0.6 IW/CPE with 6 cm depth at each irrigation.

Table 2. Main stem girth (cm) at 0.5 m AGL during different growth stages of ber as influenced by quantity of water appplied through drip method of irrigation

Treatments	1994-95			1995-96		
	Begining of Season	Fruit development	Prruning	Beginning of season	Fruit development	Pruning
T_1	10.71	15.71	17.71	19.58	25.12	29.10
		(46.7)	(65.3)	(82.8)	(134.5)	(174.5)
T_2	9.96	16.57	17.14	17.56	22.80	25.94
		(66.4)	(72.1)	(76.3)	(128.9)	(160.4)
T_3	11.90	19.14	19.14	21.96	25.12	30.70
		(60.8)	(60.8)	(84.5)	(111.1)	(157.9)
T_4	12.08	18.71	19.00	22.52	29.32	31.38
		(54.9)	(57.3)	(86.4)	(142.7)	(159.8)
T_5	10.97	18.57	18.57	20.34	28.13	28.70
		(69.3)	(69.3)	(85.4)	(156.4)	(161.6)
T_6	10.93	16.85	16.85	19.10	26.19	27.20
		(54.2)	(54.2)	(74.7)	(139.6)	(148.8)
T_7	9.96	16.14	17.42	20.16	29.39	30.20
		(62.0)	(74.9)	(102.4)	(195.1)	(203.2)
T_8	10.43	17.00	17.14	18.42	27.00	27.24
		(63.0)	(64.3)	(76.6)	(158.9)	(161.2)
T_9	10.87	15.85	16.71	19.10	24.74	27.00
		(45.8)	(53.7)	(75.7)	(127.6)	(148.4)
T_{10}	9.64	12.28	12.42	12.60	19.97	22.62
		(27.4)	(28.8)	(30.7)	(107.1)	(134.6)
S.Em$\pm$	0.93	0.92	1.08	1.34	1.23	1.31
C.D. (0.05)	NS	2.62	3.05	3.86	3.52	3.76

Figures in parenthesis indicate cumulative per cent increase over first observation

AGL= above ground level, N.S.= Not significant

from flower initiation stage of 1994-95 to fruit harvest stage of 1995-96. Under drip irrigated treatments the mean per cent coverage was 16.2 and 29.8 during 1994-95 and 34.3 and 59.9 during 1995-96 at flower initiation and fruit harvest stages, respectively.

Significantly the lowest canopy volume of 2.30 and 11.96 cu m./tree was recorded in rainfed control compared to all irrigated treatments except T_1 in 1994-95 and T_1 and T_2 in 1995-96 (Table 3). Among drip irrigated treatments the maximum canopy volume was recorded in T_6 (8.22 cum tree) which was significantly higher over T_1 and T_2 during 1994-95. However, T8 recorded the highest canopy volume of 20.46 cu.m/tree during 1995-96 and it was significantly vary to that recorded in T_1(14.44) and T_2(14.66).

The data on main stem girth, canopy coverage and canopy volume as obtained under various treatments was attributed to favourable soil moisture conditions. In drip irrigation treatments the soil water regime was maintained which helped in better growth of ber tree.

In the present investigation ber responded to application of irrigation water significantly (Table 4). The average fruit yield under rainfed condition was 8.0 q per ha which was increased by 3.2 times under surface irrigation system. Further, the increase in fruit yield was 2.9 to 4.0

Table 3. Canopy coverage and canopy volume of ber at different stages as influenced by quantity of water applied through drip irrigation

Treatments	Conopy coverage (sq.m/tree) 1994-95		1995-96		Canopy volume (cu.m/tree)	
	Flower initiation	Fruit harvest	Flower initiation	Fruit harvest	1994-95	1995-96
T_1	4.22 (11.7)	8.28 (23.0)	12.56 (34.9)	20.89 (58.0)	4.36	14.44
T_2	3.83 (10.6)	8.02 (22.3)	11.67 (32.4)	19.64 (54.5)	5.16	14.66
T_3	5.91 (16.4)	11.72 (32.5)	11.57 (32.1)	20.64 (57.3)	6.82	17.52
T_4	7.79 (21.6)	12.99 (36.1)	11.97 (32.2)	20.84 (57.9)	7.40	17.76
T_5	6.34 (17.6)	11.74 (32.6)	13.02 (36.2)	21.53 (59.8)	7.64	19.24
T_6	6.54 (18.2)	11.76 (32.7)	12.35 (34.3)	22.01 (61.1)	8.22	18.64
T_7	6.13 (17.0)	10.87 (30.2)	12.99 (36.1)	24.02 (66.7)	7.10	19.40
T_8	6.04 (16.8)	10.36 (28.8)	12.61 (35.0)	23.01 (63.9)	7.46	20.46
T_9	4.30 (11.9)	8.87 (24.6)	12.56 (34.9)	21.94 (60.9)	4.98	17.30
T_{10}	2.19 (6.1)	4.47 (12.4)	8.63 (23.9)	17.73 (49.2)	2.30	11.96
S.Em.±	0.60	0.87	0.62	1.04	0.76	1.12
C.D. (0.05)	1.69	2.46	1.78	3.02	2.18	3.20

Figures in parenthesis indicate percentage of area to total area per tree

times under varios drip irrigated treatments. This clearly indicated that ber is a responsive crop to irrigation. This is also evidenced from the reports of Pareek (1983) and Belgaumi (1992).

In drip irrigation system, water was applied frequently thereby increasing average soil water potential (Hillel, 1972). The variations in the fruit yield of ber due to application of irrigation water through drip (T_1 to T_8) could be primarily attributed to the differences in the quantity of water applied. The quantity of water applied increased from T1 to T8 on account of higher discharge per unit time. The response of the crop therefore depended on the quantity of moisture available throughout the growing period. Comparatively low yield of ber was recorded in surface method of irrigation irrigation over T3 to T8 due to moisture stress experienced between two irrigations which was absent in these treatments. Among the drip treatments of T3 to T8 the highest fruit yield of ber (32.9 q/ha) was obtained in T7 closely followed by T8 (32.6 q/ha). However, they were on par with rest of the treatments. Crops are said to respond for increased rate of irrigation water but to certain limit. Thereafter, the response may taper down. Similar phenomenon in the present investigation was observed. The data obtained could be supported with findings of Hegde and Srinivas (1990), in case of banana.

The ber fruit yield obtained under individual years also indicated similar trends to that observed in pooled analysis. However, the fruit yield in 1994-95 was lower compared to that obtained during 1995-96. the fruit yield in ber is said to increase with advancement of age with stabilised productivity from sixth year onwards.

The ber fruit yield produced under T_3 was 30.2q per ha which was significantly higher compared to fruit yield produced under surface method of irrigation. Subsequent increase in water application rates did not produce significantly higher fruit yield except in T_7. In addition the quantity of water applied in T_3 was 61.5 to 66.3 per cent less compared to surface irrigation (Table 4). Further the water -use-efficiency recorded in T3 was 1.33 to 3.82 q per ha-cm which was higher than that recorded in subsequent water application rate treatments (T_4 to T_8) and surface irrigation method.

From the above it can be safely inferred that, scheduling of irrigation through drip considering 60 per cent wetted area with 25 per cent pan evaporation or 20 per cent wetted area with 75 per cent pan evaporation could be employed for getting optimum ber fruit yield during its early growth period.

Table 4. Fruit yield (q/ha), saving in water (%) and water-use- efficiency (q/ha- cm) of ber as influenced by drip irrigation treatments.

Treatments	Fruit yield			water saving (over T9)		water -use efficiency	
	1994-95	1995-96	Mean	1994-95	1995-96	1994-95	1995-96
T_1	8.2	37.7	23.0	87.2	88.7	2.30	8.32
T_2	13.0	42.7	27.9	74.4	77.5	1.87	5.28
T_3	13.8	46.5	30.2	61.5	66.3	1.33	3.82
T_4	15.3	45.5	30.9	48.7	55.0	1.10	2.81
T_5	14.9	47.9	31.4	23.1	32.5	0.71	1.97
T_6	14.3	47.4	30.8	-2.5	10.0	0.51	1.46
T_7	14.9	50.8	32.9	-15.4	-1.2	0.48	1.39
T_8	16.5	49.1	32.6	-53.9	-34.9	0.39	1.01
T_9	13.2	38.3	25.8	-	-	0.49	1.06
T_{10}	4.2	11.3	8.0	-	-	-	-
S.Em±	1.2	1.9	0.9	-	-	-	-
C.D. (0.05)	3.4	5.6	2.7	-	-	-	-

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