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EFFECT OF DRIP IRRIGATION ON GROWTH OF IMMATURE RUBBER

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In an experiment conducted at Punalur, Kerala, to study the effect of irrigation on the growth of immature rubber (*Hevea brasiliensis*) with drip irrigation at 25, 50, 75 and 100 per cent of crop evapotranspiration and a control without irrigation as the treatments, it was observed that irrigation at 50 per cent of the crop evapotranspiration was sufficient for improving the growth. Irrigation during the summer season increased the growth of rubber plants significantly. Irrigated plants maintained a higher leaf water status during summer season.

Key words: Drip irrigation, *Hevea brasiliensis*, Leaf water potential.

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INTRODUCTION

In the traditional rubber growing areas of Kerala in India, summer season extends from December to April. During this period, very few summer showers are received and the plants experience moderate to severe soil moisture stress. Rubber (*Hevea brasiliensis*) is usually cultivated as a rainfed crop in these areas and requires about seven years to attain tappable girth.

Earlier studies have reported that maintenance of a favourable moisture status in soil enhances the growth and reduces the immaturity period of rubber (Ninane, 1967; Pushparajah and Haridas, 1977; Omont, 1982). In the North Konkan region of India, the immaturity period of rubber could be reduced from 10 to 6 years by giving irrigation (Vijayakumar *et al.*, 1998).

Information regarding the benefits of irrigation on the growth of rubber in the traditional rubber growing areas is limited. An observational trial conducted in Central Kerala indicated that irrigation increased the growth of immature rubber (RRII, 1987). Jessy *et al.* (1994) also reported enhanced growth of rubber in Central Kerala as a result of irrigation in summer.

Under conditions of limited water supply, drip irrigation could be ideal for plantation crops like rubber due to its high conveyance and application efficiencies. Compared to other methods, labour requirement is also less for drip irrigation. The present investigation was taken up to study the effect of drip irrigation on growth of immature rubber.

MATERIALS AND METHODS

The experiment was conducted in an estate at Punalur in South East Kerala (9° N and 76° 55′ E). This region experiences a warm humid climate with a mean annual rainfall of 250-300 cm. Major part of the rainfall (40-50%) is received during the South West monsoon season (June – August) and the rest during the North East monsoon season (September – November). The summer season (December - April) receives few showers and experiences a moderate soil moisture deficit. Compared to other parts of Central and Southern Kerala, Punalur area experiences a higher temperature during the summer season. The weather data during the period of experimentation is given in Table 1. The data on rainfall was

Table 1. **Weather data for the summer seasons (1991-'96)**

Month	Temperature (°C) Max.	Temperature (°C) Min.	RH (%)	Total rainfall (mm)
December	32.6	20.7	74.4	19.1
January	33.0	20.2	67.1	16.4
February	33.5	21.1	69.5	49.8
March	34.0	22.0	69.5	44.5
April	34.1	23.5	76.4	185.7

recorded from a raingauge installed in the estate and the remaining data were collected from the India Meteorology Department, Thiruvananthapuram. Soil moisture retention at field capacity (0.03 MPa) was 19.8 per cent and that at wilting coefficient (1.5 MPa) was 12 per cent.

Polybag plants of clone PB 311 were planted during July 1991 at a spacing of 6.65 x 3.35 m in randomized block design with five treatments and five replications. Drip irrigation at four levels (25, 50, 75 and 100% of crop evapotranspiration) and a control without irrigation were the treatments. The irrigation was given from the first week of December, when the plants were five months old. Observations were recorded from eight plants in each plot from a gross plot size of 10 plants. Crop evapotranspiration (ETc) was calculated from the reference crop evapotranspiration (ETo) computed using the Hargreave's method (Hargreaves and Zamani, 1982) and a crop coefficient of 0.87 (Jessy *et al.*, 1992). Reference crop evapotranspiration was estimated on a monthly basis during summer season and the quantity of irrigation was changed accordingly.

The quantity of irrigation was increased every year corresponding to the increase in the evapotranspiration demand of the plants (Table 2). Drip irrigation system was installed before the commencement of the experiment. Irrigation was given daily through emitters of discharge rate 2 L/h and 4 L/h. Two emitters of discharge rate 2 L/h were used for 0.25 ETc and four such emitters for 0.50 ETc for each plant. Three emitters of 4 L/h weres used for 0.75 ETc and four such emitters for 1.00 ETc for each plant. The operating time was increased corresponding to the increase in the irrigation water requirement with age of the plant. The canopy area of the plants were recorded before the commencement of irrigation during every year to calculate the quantity of irrigation water to be applied. The emitters were connected to a lateral line placed along the platform. During the first year emitters were placed at 15 cm away from the plant base and during the subsequent years, the emitters were moved further away as the root system of the plant developed. Irrigation was given daily from December till the onset of rains in April-May. While scheduling irrigation, the quantity of rainfall received was also taken into account. The girth of the plants was measured at 125 cm from the bud union at the beginning and end of the summer season every year. Observations on number of leaf whorls were recorded during the first year. The data were subjected to analysis of variance. Moisture content of soils collected from areas wetted by emitters and unwetted areas in the irrigated plots and from the corresponding

Table 2. **Quantity of irrigation water applied (L/plant) for different treatments during summer season**

Treatment	1991-92	1992-93	1993-94	1994-95	1995-96
0.25 ETc	619 (4.1)	1216 (5.4)	1624 (10.8)	3451 (22.9)	4357 (29.0)
0.50 ETc	1238 (8.3)	2433 (10.8)	3247 (21.5)	6902 (45.8)	8713 (58.0)
0.75 ETc	1858 (12.3)	3649 (16.2)	4871 (32.3)	10353 (68.7)	13070 (86.6)
1.00 ETc	2478 (16.4)	4865 (21.5)	6494 (43.0)	13804 (91.6)	17426 (115.4)

Figures in parentheses indicate average quantity of water applied per plant per day positions in the unirrigated plots was measured gravimetrically at monthly intervals during the irrigated season. Mid-day leaf water potential was measured using a dew point microvoltmeter (Wescor USA) from the middle leaflet of the middle leaf of the youngest fully mature flush on each plant in the fourth year of planting.

RESULTS AND DISCUSSION

Number of leaf whorls recorded before the commencement of treatments and three months after starting irrigation did not indicate any significant difference between treatments (Table 3). However, at the end of seven months, plants irrigated at 50 per cent and above of ETc had higher number of leaf whorls compared to the unirrigated plants, which might be due to the beneficial effect of irrigation on improving the growth of rubber.

Pretreatment observations on the girth of rubber were recorded in December 1991, before commencing irrigation. Response of rubber plants to irrigation in terms of girth and girth increment was significant from the second year of irrigation (Table 4). During the first year (1991-92), summer showers were received during all the months, and this might be the reason for the lack of response to irrigation during that period. During the second year, no rainfall was received during January to March and plants irrigated at 50 per cent and above of ETc were significantly superior to the unirrigated plants with respect to girth and girth increment. During the third year fairly distributed summer showers were received and all the irrigated plants remained superior to the control plants. There was no significant difference between the different levels of irrigation. During the fourth year, the total rainfall and distribution during the summer period were comparatively less and plants irrigated at 50 per cent and above ETc were significantly superior to the control plants while the plants irrigated at 25 per cent of the ETc was comparable to the unirrigated plants. During fifth year also, rainfall was received in all the months except in December and all the irrigated plants remained significantly superior to the unirrigated plants with respect to girth and girth increment.

From the data it appears that the response of plants to irrigation is mainly influenced by the quantity and distribution of

Table 3. **Mean number of leaf whorls per plant during first year**

Treatment	December	March	July
No irrigation	4.85	6.70	8.59
0.25 ETc	5.10	7.13	9.14
0.50 ETc	5.00	7.42	10.01
0.75 ETc	5.24	7.42	9.74
1.00 ETc	5.42	7.94	10.08
SE	0.25	0.31	0.35
CD ($P \leq 0.05$)	NS	NS	1.05

Table 4. **Girth and girth increment of rubber (cm)**

Treatment	Girth (cm)						Girth increment (cm)				
	1991	1992	1993	1994	1995	1996	1992	1993	1994	1995	1996
No irrigation	6.21	6.49	14.09	24.24	35.38	37.51	0.41	8.07	18.22	29.34	31.48
0.25 ETc	6.67	7.25	15.94	27.28	37.51	40.94	0.57	9.26	20.61	30.83	34.27
0.50 ETc	6.57	7.30	16.96	27.47	38.18	41.34	0.73	10.39	20.91	31.65	34.36
0.75 ETc	6.61	7.90	17.25	27.75	38.21	41.26	1.29	10.64	21.60	32.06	35.26
1.00 ETc	7.05	8.02	17.60	28.97	39.53	42.71	0.98	10.56	21.92	32.48	35.66
SE	0.33	0.37	0.65	0.75	0.91	0.96	0.20	0.42	0.64	0.65	0.79
CD ($P \leq 0.05$)	NS	NS	2.02	2.70	2.79	2.97	NS	1.28	1.96	2.01	2.44

rainfall during the summer season. When fairly distributed summer showers were received, all the irrigated plants were superior to the unirrigated plants and if not, only the plants irrigated at 50 per cent and above the ETc were significantly superior.

In the North Konkan region, very good response to irrigation was reported (Mohankrishna *et al.*, 1991; Chandrasekhar *et al.*, 1994). However, in the present experiment, although irrigation enhanced girth, the magnitude of response was not substantial. In Central Kerala, a growth improvement of 7 cm was obtained by providing drip irrigation for five years at 50 per cent of ETc for the clone RRII 105 (Jessy *et al.*, 1994). The probable reason for the low response to irrigation observed in the present study may be that the severity of the drought in the experimental area was much low compared to North Konkan. The water deficit during the summer season in the traditional areas was estimated to be around 350 mm while it was around 1070 mm in North Konkan (RRII, 1988). The summer showers received in the experimental area from December to April might have reduced the intensity of the moisture stress. Clonal differences in the response to irrigation also cannot be ruled out. Haridas (1980) reported clonal differences in plant growth response to irrigation in Malaysia. In a nursery experiment he observed that when 25 per cent of estimated soil moisture deficits were replenished for over six months, for the clone RRIM 703, there was an increase in dry matter production by 17 per cent over control, but for PB 235, there was no such response. It was also noticed that irrigation (50%) around the base of the plants during dry spells brought about a 4 cm girth advantage over control in 12 months for the clone RRIM 703, but GT 1 and RRIM 612 did not show any response to irrigation.

Irrigation at 50 per cent and above of the ETc did not make any difference, up to the 5th year of irrigation. Hence, when water availability is limited, irrigation can be given at 50 per cent of the actual plant requirement, without affecting the growth of plants. Vijayakumar *et al.* (1998) also reported the irrigation requirement during summer as 50 per cent of the crop water requirement in the North Konkan.

Leaf water potential measured during the summer season indicated differences between the irrigated and unirrigated treatments (-2.06, -1.69, -1.42, -1.48 and –1.44 MPa for the unirrigated, 0.25, 0.50, 0.75 and 1.00 ETc treatments respectively). The unirrigated plants had the lowest leaf water potential and all the irrigated treatments maintained a higher leaf water potential. However, plants irrigated at 0.50 ETc and above had almost similar leaf water potential indicating that irrigation at 0.50 ETc was sufficient to maintain plant water status.

Before starting irrigation in December, the mean soil moisture content in the surface soil (0-30 cm) was 15.50, 15.62, 15.58, 14.26 and 15.15 per cent for the unirrigated, 0.25, 0.50, 0.75 and 1.00 ETc treatments respectively. Soil moisture recorded from the area wetted by emitters in the irrigated plots and from the unirrigated plot in March 1995 are shown in Table 5. As the summer season advanced, soil moisture content depleted near to the wilting point in the surface layers of the unirrigated plots during March but the irrigated plots had higher soil moisture content at all the depths studied. Soil moisture content was the highest in 45-

Table 5. **Soil moisture content (%) under different treatments**

Depth (cm)	No irrigation	0.25 ETc	0.50 ETc	0.75 ETc	1.00 ETc
0-15	11.27	18.61	21.02	23.30	23.94
15-30	15.34	18.55	23.43	26.07	23.39
30-45	14.53	17.67	21.70	27.11	27.17
45-60	15.38	15.78	20.08	24.23	23.03

60 cm layer in the unirrigated plot, whereas it was higher in upper layers in irrigated plots. Considering the growth and leaf water potential of the plants, drip irrigation in summer at 50 per cent of ETc appeared to be the optimum.

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