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INFLUENCE OF IRRIGATION AND MULCHING ON SOIL MOISTURE AND SOIL TEMPERATURE UNDER COCONUT IN LITTORAL SANDY SOIL*

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Soil moisture and soil temperature are the two most important physical factors which influence various processes such as evapotranspiration, growth, development and biological activity of plants (Lal, 1974). The importance of mulching has been well recognized in the field of agriculture and farmers have been traditionally practicing mulching for their crops using locally available materials like dry leaves, coconut husk etc. The efficacy of irrigation can be increased by mulching the irrigated area. In addition, the favourable effect of mulch on soil temperature regulation (Varadan and Rao, 1983), improvements in soil physical properties and yield of crops have been established (Adams, 1970, Ketcheson and Beauchamp, 1978 and Jayasree and Pushkala, 1990). In a humid tropical climate, littoral sandy soils show very high temperature at the surface during dry periods. Sudden changes of high magnitude in soil temperature are more deleterious to plants than slow changes (Daubenmire, 1974). The information on effect of irrigation and mulching on soil moisture and soil temperature in littoral sandy soil is meagre. Keeping in view of the above aspects, a field experiment was conducted with the objectives of studying the effect of mulching and irrigation on soil temperature and soil moisture in littoral sandy soil under coconut.

The experiment was conducted at Central Plantation Crops Research Institute, Kasaragod during the non rainy seasons of 1993-94 and 1994-95, in the coconut garden planted in 1972 with West Coast Tall Variety. The average pre experimental yield during 1991-93 ranged between 35-40 nuts per palm per year. The design of the experiment was split plot involving irrigation treatments in the main plot viz., T_1: Drip irrigation at the discharge rate of 1.0 lph, T_2: Drip irrigation at the discharge rate of 1.5 lph, T_3: Drip irrigation at the discharge rate of 2.0 lph, T_4: Basin irrigation at the rate of 100% of E_0 once in 4 days through hose pipe, and T_5: Rainfed control. The sub-plot treatments included were: M_0: No mulch and M_1: Mulching with coconut leaves (15 numbers coconut leaves were used to cover the 1.8 m radius of coconut). Under drip irrigation, the quantity of water applied was 100% of mean evaporation (mm/day) calculated on monthly basis during the period of December to May (48 litre of water per palm per day) and six emitters/palm were placed at equidistance from the trunk.

The soil of the experimental field was classified as littoral sand (Quartzipsamments) with a mechanical composition of 95.8% coarse sand, 3.3% fine sand, 0.2% silt and 0.7% clay. The field capacity of the soil was 4.2%, wilting point was 0.44% with a bulk density of 1.66 g cc^{-1}.

Soil thermometers were placed at 15, 30 and 45 cm depth in different treatments. Under drip irrigation, they were placed 25 cm away from the dripping point. The soil temperature was recorded twice daily during 7.30 and 14.30 hours. Soil moisture content was determined by gravimetric method by collecting soil samples in the 0-25, 26-50, 51-75 and 76-100 cm depths during February- March months. Under drip irrigation soil samples were collected about 25 cm away from the dripping point. Under basin irrigation, it was

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determined every day during the four day cycles of irrigation. The available soil moisture in one meter depth was calculated using the standard procedure. The water holding capacity of the soil was 62.4 mm m^{-1} depth.

Soil moisture

The available soil moisture under different treatments is presented in Table 1 and Table 2. The available soil moisture in the active root zone depth was higher under the drip with mulch compared to drip without mulch. Under drip irrigation at different discharge rates, the available soil moisture in the one meter depth ranged from 48.4 to 54.0 mm under mulch, whereas it was 34.6 to 36.0 mm under no mulch treatment. Mulching the basin area of 1.8 m radius with coconut leaves conserved the soil moisture effectively, and it was 22.2 to 28.8 per cent more over mulch free treatment. Balasubramanian *et al.* (1985) reported higher soil moisture content under coconut leaf mulch in a coconut garden in sandy loam soil. In another study, under sandy loam and laterite soil, mulching with green leaves and coconut leaves respectively conserved soil moisture efficiently (Varadan *et al.* 1990 and Joseph *et al.* 1994). Under basin irrigation, available soil moisture was higher under mulch compared to no mulch treatment. On fourth day after irrigation (i.e. before next irrigation) the available soil moisture in the root zone under mulch was 36.8 to 37.6 mm whereas it was 18.2 to 19.9 mm under no mulch. As compared to the first day after irrigation, the moisture depletion on fourth day after irrigation, under mulch was 30.4 to 33.3 per cent, whereas it was 59 to 64 per cent under no mulch treatment. In the rainfed control, the soil moisture in the shallow depth of 0-50 cm

Table 1. ***Available soil moisture (mm/m depth) under drip irrigation tratments***

Depth (cm)	Available soil moisture (mm/m depth)											
	1.0 lph				1.5 lph				2.0 lph			
	M_1		M_0		M_1		M_0		M_1		M_0	
	a	b	a	b	a	b	a	b	a	b	a	b
0-25	11.4	12.1	7.0	7.4	11.4	11.0	7.0	7.4	11.4	12.6	7.4	7.0
26-50	14.8	15.6	8.2	8.3	13.8	14.1	8.2	8.3	15.0	15.6	8.6	9.0
51-75	13.9	14.2	9.8	9.8	13.0	13.6	9.6	10.0	13.6	13.8	10.2	10.6
76-100	11.4	12.1	9.6	9.6	10.2	10.6	9.8	10.0	11.6	11.6	9.0	9.4
Total	51.5	54.0	34.6	35.1	48.4	49.3	34.6	35.7	51.6	53.6	35.2	36.0

lph: litre per hour
M_1: With mulch M_0: Without mulch a: 1993-94, b: 1994-95

Table 2. ***Available soil moisture (mm/m depth) under basin irrigation treatment.***

Depth (cm)	Available Soil Moisture (mm/m depth)															
	1st DAI				2nd DAI				3rd DAI				4th DAI			
	M_1		M_0		M_1		M_0		M_1		M_0		M_1		M_0	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
0-25	15.0	14.6	13.8	13.4	13.8	13.8	10.2	9.4	11.8	11.4	7.0	6.6	9.8	10.2	2.6	3.0
25-50	12.6	12.2	11.8	11.4	11.0	10.6	9.4	9.8	10.2	10.6	7.8	7.2	7.8	8.2	2.2	3.0
50-75	13.4	13.0	12.2	11.8	11.0	11.0	10.6	10.6	9.0	9.0	6.6	6.2	9.0	8.6	5.4	5.0
75-100	12.6	12.6	11.0	10.2	9.8	9.4	7.8	7.8	9.8	9.2	7.0	7.2	8.6	9.0	6.2	6.6

DAI: Days after irrigation
M_1: With mulch, M_0: Without mulch a: 1993-94, b: 1994-95

was near to the permanent wilting point (0.44%) and in the deeper depth of 50-100 cm, it was just above the wilting point (0.60%) irrespective of mulching or no mulching during the period of observation showing the wilting symptoms of coconut leaves.

Soil temperature

Soil temperature recorded at different depths is presented in Figure 1 and 2. Soil temperature at different depths varied among the treatments. Generally the temperature was higher at deeper layer compared to top layer and was higher in the afternoon time (14.30 h) compared to morning time (7.30 h). The soil temperature was lower during December and gradually increased at all depths as the months progressed. Among the treatments, rainfed with or without mulch recorded the higher soil temperature (34°C at 45 cm depth during May) compared to other treatments. Under drip irrigation, the soil temperature did not show any appreciable difference due to the discharge rates of emitters. Treatments receiving drip irrigation and basin irrigation with mulch recorded the lower soil temperature (26.1 to 29.3°C) compared to unmulched treatments (27.7 to 30.9°C) at 15 cm depth during different months. By mulching there was reduction in the soil temperature by 1.6 to 1.7°C at 15 cm depth compared to no mulching under irrigation. The increase in temperature in a day from 7.30 h to 14.30 h at 15 cm depth ranged from 0.1 to 0.4°C, under drip mulch, whereas it was 0.1 to 0.7°C under dril no mulch treatment. Under basin irrigation also it was 0.1 to 1.0°C (mulch treatment) and 0.5 to 1.8°C in no mulch treatment. The increase under rainfed no mulch treatment was 0.3 to 2.3°C. Mulching with coconut leaves not only reduces the incidence of solar radiation

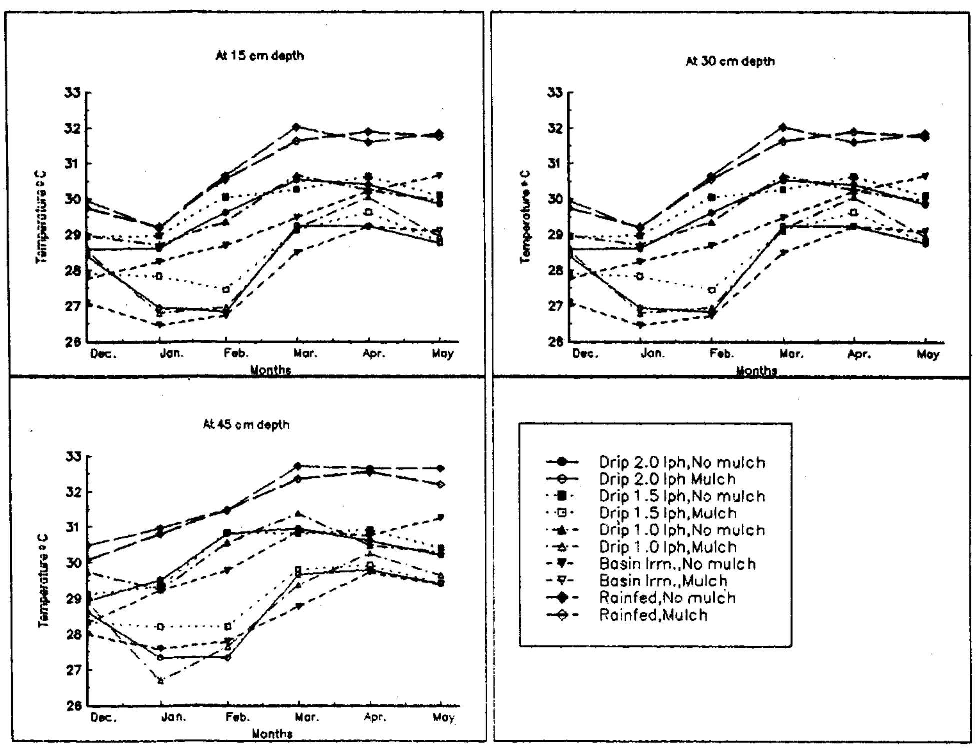

Fig. 1. Soil temperature at different depths as influenced by different treatments during 7.30 hrs.

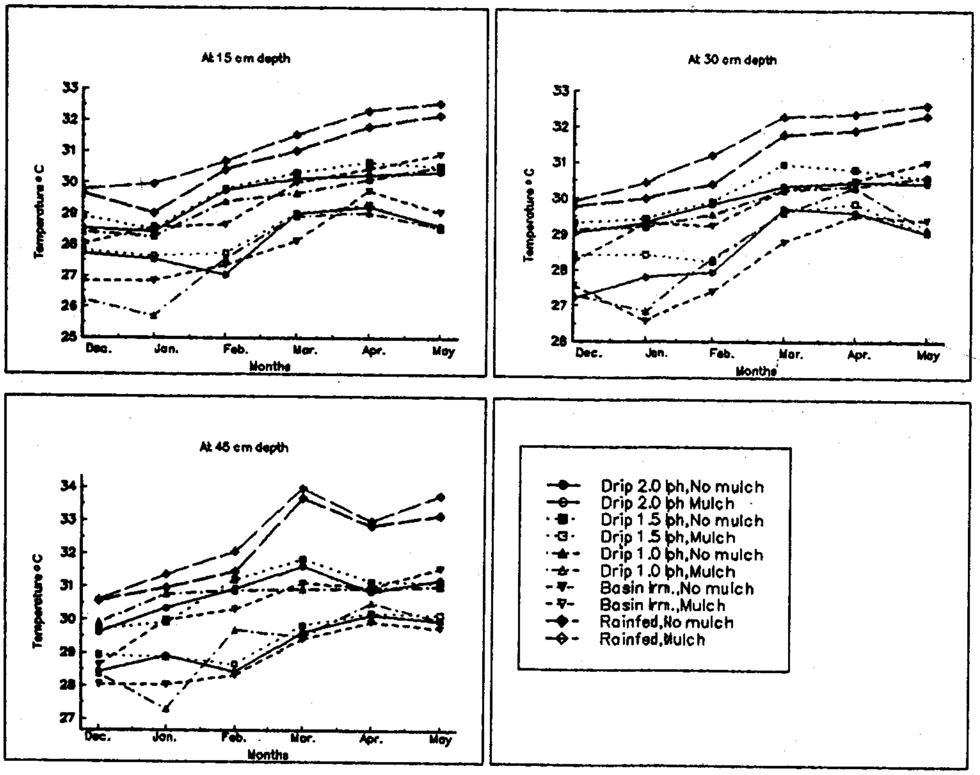

Fig. 2. Soil temperature at different depths as influenced by different treatments during 14.30 hrs.

on the soil surface, but also acts as a buffer to reduce the heat flow from the soil during night hours and, therefore, the diurnal variations are minimal. Lal (1974) reported that by rice straw mulching in maize grown in tropical soils of Ibadan, temperature differences of, as much as 8°C were observed between mulched and unmulched plots at a 5 cm depth. Varadan and Rao (1983) reported that under laterite soil the decrease in soil temperature due to mulch was 2-6°C in surface depths of 5 and 10 cm in coconut. In sandy loam soil temperature under green leaf mulch treatment was lower compared to no mulch and polythene mulch in coconut gardens (Varadan *et al., 1990). Under rainfed situation the soil temperature was higher in no mulch treatment and mulching could reduce the soil temperature by 0.9*°C at 15 cm depth. Due to irrigation with mulching there was reduction in the soil temperature to the maximum of 4.1 to 4.3°C compared to rainfed nomulch during different months at different depths. Mulching with coconut leaves avoids the direct heating of the soil, thus preventing the rise in soil temperature. Moist soil is usually cooler than dry soil. One reason for this is the high specific heat of water, which is five times that of dry soil. Therefore, a given amount of heat/solar radiation would raise the temperature of moist soil less than that of dry soil (Cooper, 1973). As the soil moisture content is higher, the soil temperature is lower as evidenced from the lower soil temperature at different depths under drip mulch compared to rainfed no mulch. Sudden changes in soil temperature can affect the properties of plant roots, especially the absorption of nutrients and water, besides the biochemical processes. Murray (1973) has reported accentuation of the fall of immature nuts, 3-4 months old, when rain follows a drought or at the end of a long dry spell due to sudden changes in soil temperature as observed in the no mulch plots.

From the above discussion it may be seen that, the soil moisture content was higher in mulched basins compared to no mulch treatment. The available soil moisture under drip mulch was higher by 22.2 to 28.8 per cent compared to drip without mulch. In basin irrigation also, on fourth day after irrigation, the available soil moisture stored in the mulch was 36.8 to 37.6 mm and it was 18.2 to 19.9 mm under unmulch, indicating the moisture depletion higher by 28.6 to 30.7 per cent compared to moisture present on first day after irrigation. Similarly, there was reduction in the soil temperature under irrigated, mulched plots by 4.3°C compared to unmulched rainfed plots at 15 cm depth. From this study we can conclude that drip irrigation along with mulching will be an useful practice with regard to both soil moisture conservation and soil temperature regulation in case of littoral sandy soil.

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