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MOISTURE MOVEMENT IN ACTIVE ROOT ZONE OF COCONUT UNDER DRIP IRRIGATION IN LITTORAL SANDY SOIL

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Drip irrigation is gaining importance in many orchard crops to efficiently utilize the limited available water resources and maximize the water use efficiency. Partial soil wetting under drip irrigation in wide spaced crops is a factor which requires clear understanding. This is because reduced wetted soil surface generally leads to many agronomic benefits such as water, labour and energy saving. The pattern of wetting front will be different under drip irrigation for different soils due to variations in soil texture, permeability, presence or absence of impermeable layers etc. The extent of wetted volume under drip irrigation is a function of the emitter discharge rate, emitter spacing, total water added and infiltration rate of the soil (Warrick, 1986). Studies on the wetting front under different soil conditions are a prerequisite in deciding the discharge rate to be maintained and the number of emitters to be used to wet the desired volume of the soil.

A short term field study on wetting front under drip irrigation was conducted at Central Plantation Crops Research Institute, Kasaragod during non-rainy period of January-April, 1994 in coconut garden with West Coast Tall palms. The soil of the experimental field was classified as littoral sandy soil with a mechanical composition of 95.8% coarse sand, 3.3% fine sand, 0.2% silt and 0.7% clay. The bulk density of the soil was 1.66 gcc^{-1}.

The wetting front measurements were done under three discharge rates of emitters, namely 1.5 litre per hour (r_1), 2.0 litre per hour (r_2) and 4.0 litre per hour (r_3). Eight litres of water was applied per dripping point per day, thus making 32 litres of water per palm per day through four dripping points as suggested by earlier research workers (Varadan and Madhava Chandran, 1991). For maintaining uniform emitter discharge rates, constant water head was maintained in the storage water tank by providing a float. The emitters were attached to microtubes (4mm ID) and placed inside the conduit pipes to allow water to drip at about 15 cm below the surface. Emitters were adjusted manually, daily before starting water application to maintain the discharge rates. Drippers having 1.5 lph, 2.0 lph and 4.0 lph discharge were operated for five hours 20 min, four hours and two hours daily, respectively. Irrigation was given daily till the completion of the experiment. For determining the wetting front, top 15 cm soil was removed around the dripping point. The horizontal movement of water was then measured. A rectangular trench of required size was then made. Vertical movement of water from the point source and horizontal direction was then marked on transparent sheet. Thus the wetting front for a full diameter in the N-S direction was obtained. The study was repeated on another dripping point in the E-W direction as a replication and mean value of horizontal and vertical movements were recorded. Such observations were recorded for each discharge rate after day-1, day-2, day-3, day-4 and day-5 following irrigation till it crossed the active root zone depth (Kushwah *et al.*, 1973). From the mean values of the vertical and horizontal movement of moisture, volume of the active root zone of coconut (1.8 m radius) wetted by single dripping point was computed. From this single dripping point volume, the root zone wetted by four and six emitters were computed. Soil moisture was determined by gravimetric method at different depths from the dripping point and expressed in percentage.

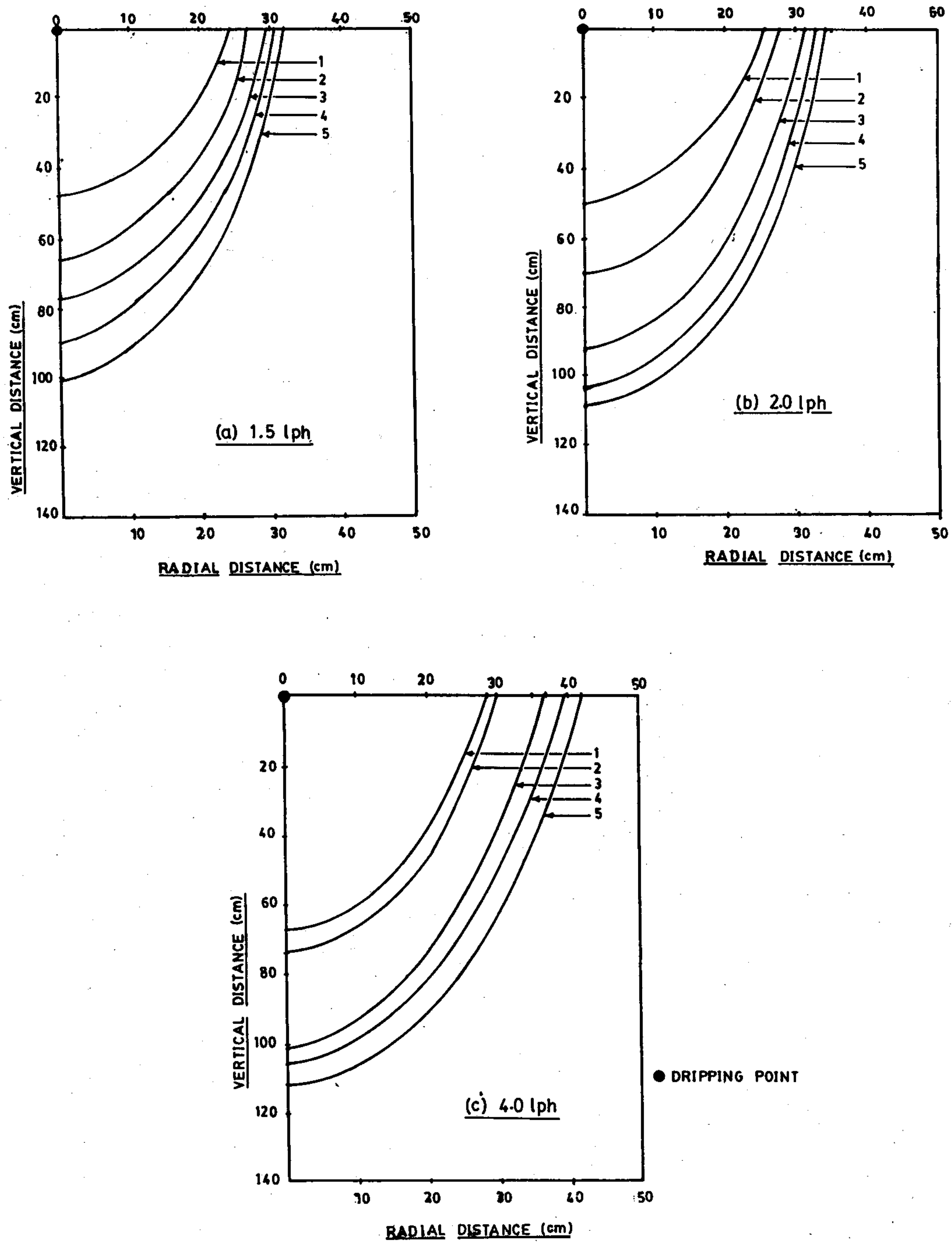

Fig. 1. Wetting fronts as influenced by discharge rate of emitters. (Numbers on each curve indicate days after regular irrigation)

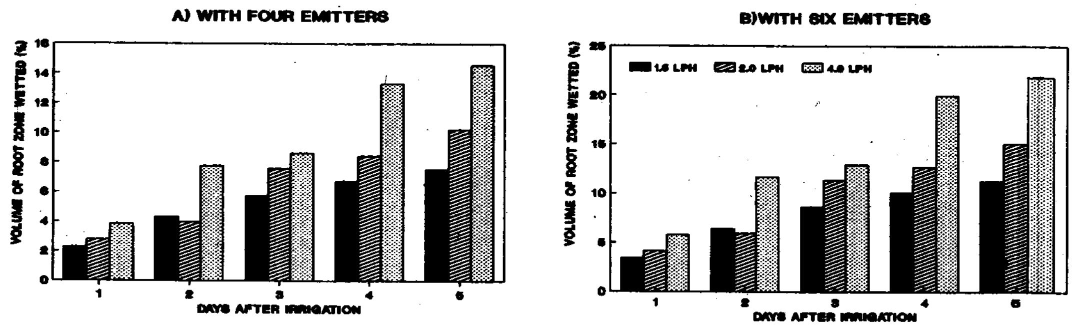

Fig. 2. Influence of discharge rate on volume of active root zone wetted

The wetting fronts as a function of time and discharge rates of water are presented in Fig. 1. The maximum vertical and horizontal movement of water was with 4.0 lph discharge rate (112 cm and 84 cm respectively) at fifth day after irrigation. Vertical movement of water was greater than the lateral due to the highly porous nature of the sandy soil which aided the gravitational force. In deep sandy soil, the capillary forces are smaller and gravity has relatively more influence. This is in conformity with the study conducted by Brand *et al.* 1971 and Vermeiren and Jobling 1984, who have reported that, with the same quantity of water and infiltration time, the sand was wetted deeper than the loams. At the discharge rate of 4.0 lph, the vertical movement had crossed the active root zone of 120 cm on third day after irrigation, whereas at 1.5 lph and 2.0 lph it had crossed the active root zone on fifth and fourth day after irrigation respectively. An increase in discharge rate resulted in an increased horizontal wetted area. On all the days under study, horizontal movement was more at 4.0 lph compared to other discharge rates. On the fifth day after irrigation horizontal movement was 64 cm, 69 cm and 84 cm at r_1,r_2 and r_3, respectively. Bresler *et al.* (1971) also reported similar pattern of distribution under coastal sandy soil.

The volume of coconut palm basin wetted by four and six emitters was related to the discharge rate (Figure 2). On the fifth day, at 4.0 lph discharge rate, 21.9% of the active root zone was wetted, whereas at 1.5 lph and 2.0 lph, the wetted volume was 11.3 and 15.1%, repectively when six emitters were used, whereas the wetted volume was 7.5, 10.2 and 14.6% at 1.5 lph, 2.0 lph and 4.0 lph, respectively when four emitters were used. Dhanapal *et al.* (1986) also reported that, at 4.0 lph discharge rate the wetted volume was larger compared to 1.0 lph, 2.0 lph and 3.0 lph discharge rate under laterite soil condition.

Table 1: ***Soil moisture content (%) as influenced by different discharge rate of emitter in littoral sandy soil (on 4th day after irrigation)***

soil depth (cm)	r_1:1.5 lph	r_2:2.0 lph	r_3:4.0 lph
0-15	*	*	*
15-30	3.96	3.80	3.54
30-45	4.28	4.22	4.22
45-60	4.03	4.05	4.11
60-75	4.20	4.00	4.02
75-90	4.02	4.33	4.01
90-105	3.71	3.99	4.13
105-120	3.23	3.62	3.88
120-135	3.10	3.45	3.22

*Emitters were placed below 15 cm, lph: litre per hour

The soil moisture content data presented in Table 1 for different discharge rates at different depths indicated that soil moisture content was almost similar at different depths as influenced by discharge rates of emitters.

The above studies indicated that the vertical and horizontal movement of water was directly related to the discharge rate of emitter, keeping quantity of water constant. The per cent of active root zone wetted was also directly related to discharge rates and number of emitters used. Therefore, under littoral sandy soil, to wet maximum volume of the soil, it is advisable to operate the emitters at 4 lph discharge rate and six dripping points per palm.

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