Soil moisture balance in relation to rainfall and evaporation

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ABSTRACT

The precipitation was considerably in excess of evaporation from June to October. The maximum surplus (988.5 mm) was in July followed by June (876.3 mm) and August (551.7 mm). The precipitation fell short of evaporation in November and continued till May, the maximum shortage being in March. The soil moisture deficit developed from September and gradually increased upto March and again decreased till May. The availablility of soil moisture in the top soil (0-15 and 15-30 cm) was nil from from November to April while the lower layers maintained 54% in March. Coconut palms should be irrigated from November to May for realising potential yield under Kasaragod conditions.

Introduction

Water balance studies are useful tools to know the general water conditions in an area, to assess the suitability of an area for a particular crop, to estimate water use by a particular crop and to examine water-yield relationships (Jackson, 1977).

Different criteria have been used by different workers in water balance approach for asseing irrigation need. Dagg and Tapley (1967) used monthly water balance approach in assessing development of water stress due to close spacing. Munro and Wood (1964) for analysing water requirements and yield of maize in Malawi used water balance approach where readings of a pan evaporimeter (122 cm dia. and 42 cm deep) were multiplied by a series of 'irrigation factors' ranging from 0.6 to 2.4. Thornthwaite ane Mather (1956) used a simple water balance approach based on rainfall and evaporation. In Kenya, Wallis (1963) examined the use of water balance method to estmate soil-water deficit and crop water use. Smith (1966) used modulated water balance approach for coconut in Trinidad. He assumed that the ratio of the actual evaporation to the potential evaporation varies linearly with the soil moisture deficit. The water balance approach was used on weekly basis to determine soil moisture deficit which was then correlated against yield of dry copra. This relation was compared with the relation between rainfall and yield for various periods, and in almost every case moisture deficit was more closely related to yield than was rainfall. In this paper, an attempt has been made to assess water need based on the findings of Gopalasundaram (1985) and substantiated by actual soil moisture measurements.

Materials and Methods

Rainfall, evaporation, soil moisture and soil temperature data from the Agri-meterological observatory at CPCRI, Kasaragod, were used for this study. The soil was a red sandy loam having FC and PWP value of 10 and 5.2 per cent (w/w), respectively. The bulk density was 1.4 g/cc. The water holding capacity of the soil was 302.4mm (upto 120 cm depth) and available water capacity 168 mm. When rainfall was in excess of evaporation, it was considered as excess and deficit when rainfall was less than evaporation. Similarly, when the total amount of available soil moisture exceeded 168 mm, it was considered as surplus and deficit when it was less than 168 mm.

Results and Discussion

A comparison of rainfall and evaporation data (Table 1) shows that from June to October, rainfall was considerably in excess of evaporation. The maximum surplus (988.5 mm) was in July followed by June (876.3 mm) and August (551.7 mm). Rainfall fell short of evaporation from November to May, the maximum shortage being in March. On annual basis, the rainfall of 1542.4 mm was in excess of evaporation. Surplus moisture was recorded from June to August which were the high rainfall months. Soil moisture deficit developed during September and gradually increased upto March and again decreased till May. This indicates the necessity of irrigation from November to May.

The data presented in Table 2 gives the picture of availability of soil moisture in different soil depths. The availability of soil moisture on top layers

Table 1. Actual soil moisture balance in different months

Month	Rainfall mm*	Evaporation mm*	Deficit/ surplus rain (mm)	Moisture balance (mm)**	Deficit surplus moisture (mm)
January	2.8	137.0	–134.2	121.4	–46.6
February	3.7	135.5	–131.8	112.8	–55.2
March	9.8	163.4	–153.6	107.3	–60.7
April	46.9	160.7	–113.8	118·0	–50.0
May	129.7	163.4	– 33.7	138.2	–29.8
June	989.7	113.4	+876.3	187.3	+19.3
July	1073.5	85.0	+988.5	187.5	+19.5
August	637.3	85.6	+551.7	170.7	+ 2.7
September	270.2	135.0	+135.2	163.0	– 5.0
October	210.8	115.3	+ 95.5	151.8	–16.2
November	89.3	117.9	– 28.6	143.2	–24.8
December	22.4	130.2	–107.8	133.6	–34.4
Total	3486.1	1542.4	1943.7		–281.2

* Mean of 20 years, ** Mean of 6 years

Table 2. Soil moisture availability (depthwise) in different months (mean of 6 years)

Month	Soil depths 0—15		15—30		30—45		45—120		Temperature		
	Act. %	Avail. %	Act %	Avail. %	Act. %	Avail. %	Act. %	Avail. %	5 cm	15 cm	30 cm
January	2.8	Nil	4.3	Nil	7.7	52	8.6	71	42.1	35.5	32.3
February	2.2	Nil	4.7	Nil	6.8	33	8.0	58	44.8	37.7	33.8
March	1.9	Nil	4.2	Nil	6.0	17	7.8	54	46.6	39.6	35.2
April	3.3	Nil	5.2	Nil	6.7	31	8.2	62	46.7	40.8	37.5
May	5.6	8	5.9	15	7.3	44	9.4	87	44.6	38.6	35.2
June	11.0	100	10.3	100	9.9	98	11.6	100	32.6	31.9	29.0
July	10.0	100	8.9	77	9.9	98	12.1	100	31.9	30.6	28.6
August	7.9	56	8.0	58	9.4	87	11.2	100	34.1	32.2	29.1
September	8.5	69	9.2	83	8.9	77	10.2	100	38.9	35.4	32.4
October	5.9	15	6.5	27	7.9	56	10.4	100	39.5	37.1	32.3
November	3.9	Nil	6.1	19	7.7	52	10.1	100	39.3	36.5	31.9
December	1.9	Nil	4.3	Nil	7.5	48	9.8	96	41.2	36.7	32.5

FC = 10%, PWF = 5.2%
Act.—Actual; Avail.—Available

(0-15 and 15-30 cm) was zero from November to April. This reflects inadequacy of rainfall during this period and fast depletion of stored soil moisture due to more exposure to solar radiation as is evident from the data on surface soil temperature. (Table 2). The lower layers maintained 100% available mositure from June to November and thereafter gradually decreased to 54% in March obviously because the lower layers were less exposed to solar radiation. This points out that heavy irrigations are not required to recharge the entire soil profile.

From the soil moisture balance studies, it is clear that for realising potential yield under Kasaragod conditions, coconut palms need to be irrigated from November to May. As the soil moisture stress is mild in November and December, there is possibility of saving water and energy by light irrigations. The irrigation requirement is maximum (154 mm) during March. During this period, heavier irrigation are required to alleviate the effect of severe drought and to obtain good yield. Since growth and reproductive phases proceed simultaneously, coconut requires readily available soil moisture throughout the year. This is also evident from the findings of Gopalasundaram (1985) that for higher production coconut palms need irrigation at IW/CPE ratio of 1.00 i.e. water requirement is equal to the evaporative demand of the atmosphere.

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