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Distribution of Precipitation by *Diospyros melanoxylon* at Sanctuary Forest, Varanasi

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The distribution pattern of precipitation was examined at Chandraprabha sanctuary forest, Varanasi. During the study years of 1976 and 1977, total annual incident precipitation was recorded as 1232.72 and 1577.50 mm respectively. The stemflow and throughfall were collected under the canopy of *Diospyros melanoxylon* Buck and Ham trees. The interception was estimated by difference of the stemflow and throughfall from the incident precipitation. The average annual values of stemflow, throughfall and interception loss were 2.49%, 62.94% and 34.57% in 1976 and 7.11%, 66.84% and 26.05% in 1977, respectively.

Key Words: **Incident precipitation (IP), Stemflow, Throughfall Interception loss**

Introduction

The knowledge of distribution and circulation of water in forest ecosystem is most essential in controlling forest productivity, classifying forest sites or evaluating the role of associated flora and fauna in community dynamics (Ovington & Madgwic 1959).

In the open area of a forest, precipitation partly reaches the ground directly. In the covered area, however the canopy breaks the force of rain and water is diverted from its course. The major portion is reaching the soil through canopy as leaf drip, i.e. throughfall, and some amount is coming down along the branches and boles, i.e. stemflow. The amount of water which is retained by the vegetation or that which evaporates during the precipitation, constitutes interception loss.

The studies on rainfall distribution pattern have been reviewed by Witch (1941), Kittredge (1948), Molchanov (1963), Sopper and Lull (1967) and recently by Boughton (1970). Indian contributions in the field of hydrologic investigation, are very limited except for a few studies made by Dabral and Nath (1962), Dabral and Subba Rao (1969) and Ray (1970).

The present communication deals the precipitation distribution under the tree *Diospyros melanoxylon* in Chandraprabha sanctuary forest, Varanasi examined over two years. It is a part of the complex

ecosystem research conducted within the framework of the MAB Programme under Project Number 1.

Site and Method

Site: The Chandraprabha sanctuary forest lies 24°52′ to 24°58′ N Lat. and 83°3′ to 83°12′ E long. It is situated at about 80 km southeast of Banaras Hindu University and is covered by a tropical deciduous forest in an undulating terrain of the Vindhyan Hills. The forest is dominated by *Anogeissus latifolia* and *Diospyros melanoxylon*. The experiments were carried out in one hectare of forest area taking note of the (b) precipitation, (c) throughfall and (d) stemflow. *Diospyros melanoxylon* was selected on account of its peculiar branching pattern, leaf structure and bark (very rough, thick with ridges and furrows) characteristics. The tree is important economically as the source of the bidi wrapping leaf.

Precipitation measurement: The precipitation was measured by putting two rain gauges, one at the forest rest house and the other in the open, adjacent to the forest area. The average of both the rain gauges was recorded daily as well as on monthly basis during the rainy season.

Stemflow sampling: Small but significant amount of water reaches to the soil as stemflow. This is expressed in terms of mm and % of incident precipitation (IP). The volume of stemflow was calculated on canopy area basis, for each tree to give the value as l/m^2 or mm. The flow was observed for 19 events during the study period. It was possible to measure the flow during minimum incident precipitation of 7.26 mm and maximum of 41 mm.

Nine trees with three girth classes (table 1) were selected for stemflow sampling, which was done according to the method reported by Liken and Eaten (1970) and Mahendrappa (1974) with suitable adjustment as per local condition Tewari (1978). Fine wiremesh pieces (20 mm width) were covered with polyethelene sheet fixed spirally around the tree trunk down from breast height (1.35 m) as channel for flow. The channel ended at a level of 60 cm from the ground surface, the point at which the flow water was received in a polyethylene carboy. Melted paraffin was poured between the polyethelene channel and the bole so that water could run smoothly without any loss. The volume of water collected in the carboy was measured and cleaned, and the carboy was kept for repeated use. Stemflow was obtained specially when a continuous shower exceeded 1.5 mm (Jackson & Aldridge 1973) or sometimes 2 mm (Aldridge & Jackson 1973).

Throughfall sampling: Throughfall was collected by placing 6 to 8 polyethylene gauges kept randomly under each tree (the same tree from which stemflow was collected). Due to long sized gauges which were not filled completely the splashing was minimised. The value of throughfall in litre/m^2 was estimated. There is occasional and intermittent drizzle from January to May each year. Heavy and frequent rains start at the end of June which continue till October when sampling was easily done. A nylon filter was fitted on the funnels of each gauge to check the litter, insects and organic debris. The gauges, funnel and filters were cleaned after and before each sampling to avoid microbial growth and dust deposition.

Interception loss: The percentage interception loss was calculated according to the following formula:

$$\% I = \frac{R-(SF+TF)\times 100}{R}$$

where I=Interception loss; R=Incident Precipitation; SF=Stemflow & TF=Throughfall

Table 1 *General characteristics of* Diospyros melanoxylon

Girth class (cm)	Basal area (m^2/ha)	Height (m)	Bole height (m)	Crown depth (m)	Maximum crown width (m)	Bark thickness (cm)	Bark character	Branching pattern	Density stem/ha.
20.20	32.12	4.75	2.90	2.60	0.85	0.64	Bark thick; dark black in colour with ridges and furrows; defoliation is common	Profuse dense branching; makes 30–80° angle at origin; leaves thick, hairy wettable on both sides	189
37.00	108.90	7.50	3.30	4.10	1.60	0.58			
54.70	235.85	8.45	4.40	4.30	2.50	1.09			

Annual depth of stemflow, throughfall and interception loss were calculated by the following formula:

$$\text{Total annual } SF/TF/I = \frac{\text{Observed } SF/TF/I + \text{Total annual incident precipitation}}{\text{Observed incident precipitation}}$$

Results and Discussion

A summary of distribution of precipitation is given in table 2 for the study period of 1976–1977. Data presented in the table are total values observed in different months.

Stemflow: Stemflow recorded in both the years, varies considerably. Minimum stemflow percentage (% of IP) is observed in the month of September (1.24%) followed by July (2.58%) in the year 1976 whereas it is found minimum in the month of June (1.67%) followed by August (2.77%) in 1977. Maximum was recorded in the month of October as 2.74% during 1976 whereas in the year 1977, it is recorded as 9.60% in the month of September followed by 8.57% in October. Higher values are noted in the months, September to October in both the years probably with the onset of dew formation. The annual values recorded in 1977 are comparatively higher (29.05 mm or 7.11%) than 1976 (5.61 mm or 2.49%). The present values are higher than the values reported by Szabo (1975—3%) and lower than those reported by Aldridge and Jackson (1973–15.4%).

Throughfall: The largest quantity of throughfall as a functional relationship of the precipitation, reaches the soil only through the canopy. It ranges from 56.16% to 68.52% in the year 1976 and 55.45% to 69.91% in 1977. The annual percentage was recorded as 62.94% and 66.84% in the year 1976 and 1977 respectively. The throughfall values are lower as compared with the values of Szabo (1975–75%), Hemilton and Rwoe (1949—80–89%) and Carlisle et al. (1965—86.8%) but resemble the values reported by Voigt (1960) and Dabral and Subba Rao (1969). In autumn and winter months i.e. in September to December the throughfall values are higher significantly. The throughfall is directly proportional to incident precipitation as it is evident from the table 2.

Interception: Interception is the relation of throughfall and stemflow. If these two parameters are recorded cautiously and accurately, the interception loss will ultimately be accurate. It depends greatly on throughfall rather than stemflow which shows the indirect relationship to throughfall. The values (% of IP) range from 29.97% to 41.26% and 22.59% to 42.88% during the year 1976 and 1977 respectively. The interception values are comparatively high in the first year (34.57%) than in the second year (26.05%). The interception values are similar to the values reported by Voigt (1960) and Ray (1970), 24.7%–33.1% and 25.3%–33.7% respectively. Dabral and Subba Rao (1969) reported 38.2% interception loss, which is higher than the present report. The interception loss is minimized considerably in the year 1977, due to improvement in sampling process of stemflow and throughfall.

Stemflow, throughfall and interception loss totally depend on the physiognomy of the tree. Their canopy structure, coverage or leaf structure, orientation and wettability, branching pattern and bark characters, influence the parameter significantly. The rainfall pattern, their storm size, duration between two showers and intensity, etc. affect the measurement of stemflow, throughfall and interception loss as well as the variability in values also to a large extent. In the present context, the characteristics of the selected tree *Diospyros melanoxylon* (table 1) reflect that much water is being lost (in terms of interception loss) from the

Table 2 *Distribution of incident precipitation (IP) as stemflow, throughfall and interception loss during 1976–1977*

Month	1976				1977			
	I P (mm)	Stemflow (mm)	Throughfall (mm)	Interception loss (mm)	I P (mm)	Stemflow (mm)	Throughfall (mm)	Interception loss (mm)
January	*				25.70	0.92 (3.58)	17.80 (69.26)	6.98 (27.16)
February	*				*			
March	*				*			
April	*				*			
May	*				*			
June	25.40	0.91 (3.38)	16.93 (66.65)	7.56 (29.97)	18.56	0.31 (1.67)	10.36 (55.45)	7.89 (42.88)
July	54.75	1.41 (2.58)	30.75 (56.16)	22.59 (41.28)	40.80	1.13 (2.27)	27.34 (67.00)	12.33 (30.23)
August	59.15	1.65 (2.79)	35.93 (60.74)	21.57 (36.47)	59.40	4.03 (6.78)	35.98 (60.58)	19.39 (32.64)
September	62.92	0.78 (1.24)	43.11 (68.52)	19.03 (30.24)	149.00	14.03 (9.60)	104.17 (69.91)	30.53 (22.56)
October	23.00	0.86 (3.74)	15.23 (66.22)	6.91 (30.04)	34.66	2.97 (8.57)	23.15 (66.79)	8.54 (24.64)
November	*				40.25	2.60 (6.46)	26.91 (66.86)	10.74 (26.68)
December	*				40.25	2.79 (6.93)	27.41 (68.10)	10.05 (24.97)
	225.52	5.61 (2.49)	141.95 (62.94)	77.96 (34.57)	408.62	29.05 (7.11)	273.12 (66.84)	106.45 (26.05)

Values in parantheses are percentage of IP
*No incident precipitation

canopy due to wettability (on both sides) of leaves, hairy structure and canopy closure (80%). It is very interesting to note that the peculiar bark character of the tree, permits much water absorption in ridges and furrows reflecting a decrease in the amount of stemflow (Tewari 1978).

The water-fall increases the physico-chemical properties of the soil (Gersper & Holowaychuk 1970a, Eschner 1967, Pandey et al. 1978 & Mahendrappa 1974). On the other hand, the interception loss cannot be considered as total loss since it increases the relative humidity of the forests and on evaporation reduces the temperature of the forest which indirectly entails an increase in the relative humidity content of the air (Szabo 1975).

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