Leaf area indices of mosses from Unchahar, Rae Bareli, Uttar Pradesh

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Leaf area indices of three mosses viz., *Barbula consanguinea* (Thw. et. Mitt.) Jaeg., *Ceratodon stenocarpus* B.S.G. and *Physcomitrium japonicum* (Hedw.) Mitt. growing around National Thermal Power Corporation (NTPC), Unchahar, Rae Bareli and in control site at Rae Bareli, about 42 km away from NTPC show variations ranging between 17.232 and 22.081 cm^2 in *C. stenocarpus*, 14.016 and 30.508 cm^2 in *B. consanguinea* and 12.994 and 27.423 cm^2 in *P. japonicum*.

Key words–Leaf Area Index. Bryophytes, Rae Bareli.

INTRODUCTION

REVIEW of literature reveals that much work has been done on the effect of air pollution on higher plants but work on the effect of air pollution on bryophytes, which are considered more sensitive than higher plants (Haseloff & Winkler, 1980), is still very poorly known. Absence of true roots and cuticle make them to derive their nutritive elements in wet and dry atmospheric deposition (Leblane & Rao, 1974; Bruning & Kreeb, 1993; Brown, 1995; Grodzinska & Lukaszewska, 2001). The suspended particulate matter along with heavy metal remains suspended in the atmosphere slowly settles down on the vegetation. These pollutants make a direct entry into the mosses through very thin and delicate leaves and indirectly in dissolved state, through rhizoids. Rao et al. (1977) observed that concentration of airborne elements in these plants can be determined by their concentration in the air, their inherent ability to absorb these elements, the ratio of plant surface to total plant mass, the ion exchange capacity of plants and the length of time of exposure.

The leaves of the plants act as good receptors of the particulate emissions produced by various sources. Thus, while estimating the fall out accumulation by plants, the foliar surface area and plant density which together give leaf area index, defined as the total area of living leaves within a unit area of moss cushion (Saxena et al., 2000), are considered as important factors.

Leaf area index is calculated by the density of plant, number of leaves per plant and size of leaves. Large leaf area means large surface for pollutants to settle which hinders the entry of sunlight into the leaves and causes reduction in the process of photosynthesis which ultimately effects the growth and development of plant. Thus reduction in density or number of leaves on the plant due to pollution directly reduces the leaf area index of the plant.

The leaf area indices of mosses growing around NTPC, Unchahar Rae Bareli and in control site are being reported for the first time.

MATERIAL AND METHOD

The collections were made from five sampling sites. Four selected sites around National Thermal Power Corporation, Unchahar are Khojanpur towards north, Gangehra towards east, Kandrawan towards west and Arkha towards south. A control site was selected which is about 42 km from the power plant area and is located in Rae Bareli. Unchahar is found to be mainly inhabited and dominated by mosses. The bryophytic flora of the area is represented by one thalloid form *Riccia grollei* Udar and five leafy forms identified as *Ceratodon stenocarpus* B.S.G., *Barbula*

consanguinea (Thw. et. Mitt.) Jaeg., *Physcomitrium indicum* (Dix.) Gangulee, *Physcomitrium japonicum* (Hedw.) Mitt. and *Funaria hygrometrica* Hedw. Three well known forms, e.g. *C. stenocarpus. B. consanguinea* and *P. japonicum* were selected to calculate the leaf area indices of mosses.

Dense population area of 1 cm^2 was selected and numbers of shoots and leaves were counted. From these shoots, 10 leaves were selected and their mean area was calculated, multiplication by number of leaves on that particular shoot provided the total leaf area on one stem. Product of number of stems per cm^2 and mean leaf area stem finally show the leaf area index. Data is condensed in the form of mean values for each species in each direction.

RESULT AND DISCUSSION

Leaf area indices of *C. stenocarpus, B. consanguinea* and *P. japonicum* are presented in Tables 1 - 3. It is very clear from the tables that the values of leaf area index depend upon the shoot density, number of leaves per shoot and area of the leaf. Leaf area index has been found variable ranging between 17.232 and 22.081 cm^2 in *C. stenocarpus*, 14.016 and 30.508 cm^2 in *B. consanguinea* and 12.994 and 27.423 cm^2 in *P. japonicum*.

In *B. consanguinea* highest leaf area index has been observed in plants growing in Gangehra (east of NTPC) whereas in *C. stenocarpus* and *P. japonicum*, it has been found in control site followed by Kandrawan (west of NTPC) Fig. 1).

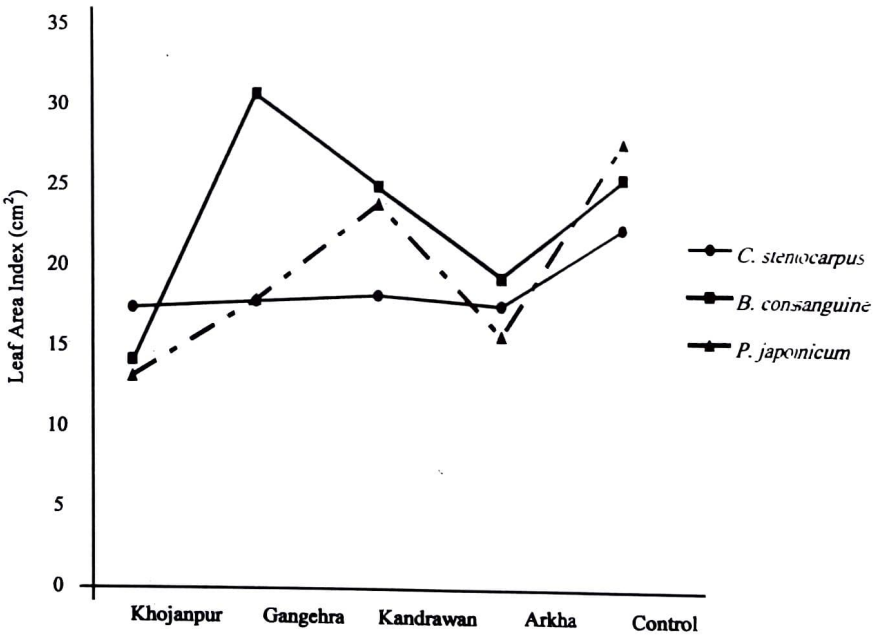

Fig. 1 : Leaf area indices of three studied mosses at five sites.

Table-1 : Shoot Density and Leaf Area Index of *C. stenocarpus*

Name of the site	Direction with respect to NTPC	No. of stem/cm^2	No. of leaves/stem	Mean leaf area of 10 leaves (mm^2)	Leaf area on one stem (mm^2)	Mean leaf area per stem (mm^2)	Leaf Area Index (cm^2)
Khojanpur	North	148.50	53.15	0.228	11.616	11.616	17.232
Gangehra	East	157.50	50.50	0.218	11.118	11.118	17.629
Kandrawan	West	150.50	52.15	0.229	11.933	11.933	18.018
Arkha	South	150.50	52.65	0.220	11.610	11.610	17.352
Control		160.75	57.15	0.238	13.754	13.754	22.081

High leaf area value does not always express high leaf area index. *P. japonicum* (Table-3) inspite of having larger leaf area than *C. stenocarpus* (Table-1) and *B. consanguinea* (Table-2) does not possess highest leaf area index due to low shoot density. Therefore, leaf area index does not depend only on mean leaf area but also on the number of shots and number of leaves per shoot. Similarly, *B. consanguinea* is found to have more or less similar shoot density in Khojanpur (north of NTPC) and Arkha (south of NTPC) but because of smaller leaf area, it possesses least leaf area index in Khojanpur i.e., 14.016 cm^2.

Leaf area indices of the three studied mosses have been found to be affected by the pollution load. Air monitoring results around NTPC categorized Arkha (south of NTPC) and Khojanpur (north of NTPC) as polluted sites and Gangehra (east of NTPC) and Knadrawan (west of NTPC) as moderately polluted and fairly clean sites respectively (Kumar & Kazmi, 2005 a, b). Around NTPC leaf area indices of *B. consanguinea* have been found to be highest in Gangehra i.e. 30.508 cm^2 (Table-2) and that of *C. stenocarpus* and *P. japonicum* in Kandrawan i.e. 18.018 cm^2 and 23.953 cm^2 respectively (Tables-1 & 3), which is attributed to low pollution load in these two sites along with other suitable factors like moisture and shade. These findings are based on field observations and can be confirmed by controlled laboratory experiments.

Large leaf area of the plant means more deposition of pollutants on the surface of leaf. The pollutants hinder the entry of sunlight in the leaf and further effect the rate of photosynthesis. On penetrating within the plant body these pollutants disturb the physiological activities of the plants which is reflected by the reduction in their growth and development. Among the studied mosses *P. japonicum* is supposed to deposit

Table-2 : Shoot Density and Leaf Area Index of *B. consanguinea*

Name of the site	Direction with respect to NTPC	No. of stem/cm^2	No. of leaves/stem	Mean leaf area of 10 leaves (mm^2)	Leaf area on one stem (mm^2)	Mean leaf area per stem (mm^2)	Leaf Area Index (cm^2)
Khojanpur	North	141.50	52.50	0.191	9.920	9.920	14.016
Gangehra	East	169.25	58.25	0.309	18.078	18.078	30.508
Kandrawan	West	167.75	55.15	0.274	15.043	15.043	24.734
Arkha	South	141.00	57.85	0.229	13.339	13.336	19.055
Control		179.50	52.90	0.267	14.174	14.174	25.197

Table-3 : Shoot Density and Leaf Area Index of *P. japonicum*

Name of the site	Direction with respect to NTPC	No. of stem/cm^2	No. of leaves/stem	Mean leaf area of 10 leaves (mm^2)	Leaf area on one stem (mm^2)	Mean leaf area per stem (mm^2)	Leaf Area Index (cm^2)
Khojanpur	North	101.00	14.60	0.905	13.291	13.291	12.994
Gangehra	East	111.50	18.90	0.873	16.694	16.694	17.724
Kandrawan	West	118.00	17.45	1.184	20.462	20.462	23.953
Arkha	South	98.50	14.75	1.077	15.839	15.839	15.490
Control		125.75	16.55	1.249	21.895	21.895	27.423

maximum amount of pollutants through the leaves due to its larger leaf area as compared to other two species but its density has been found least among the three species. Decrease in density, number of leaves per shoot and leaf area of these mosses are affected due to pollutants prevailing in the vicinity of NTPC.

Amongst the three mosses, the highest leaf area index has been observed in *B. consanguinea* from Gangehra (30.508 cm^2) because of its dense growth and large leaf area values and lowest value is reported in *P. japonicum* in Khojanpur (12.994 cm^2) due to low density and lesser number of leaves in shoots.

The leaf area index of *C. stenocarpus* is found lower than that of *C. purpureus* (Hedw) Brid. (Saxena et al., 2000). This difference is attributed to differences in the number of leaves per stem.

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