Journal of Agrometeorology 5 (2) : 43 - 47 (Dec 2003)

The variation of cloudiness and diffuse solar radiation index during *kharif* season

K.K.NATHAN
Water Technology Centre, I.A.R.I., New Delhi - 110012

ABSTRACT

Diffuse radiation index (DRI) is a useful input during *kharif* crop growing season in India as at times nearly 90% of the incoming solar radiation gets depleted. High DRI value was found in northeast regions and west coast of India (> 0.6) whereas the least value prevailed over northwest region of India (< 0.4). Significant correlation was seen between sunshine duration and diffuse radiation during *kharif* season, both along west coast (R^2 = 0.67) and east coast (R^2 = 0.55) of India.

Key words: Cloudiness, Diffuse radiation, Diffuse radiation index.

There is abundant availability of diffuse solar radiation during cloudy and turbid atmosphere. It is the total radiation of the sun that gets reflected, scattered and becomes diffuse radiation as it passes through atmosphere. The amount of diffuse radiation produced and incident on the ground surface is a fraction of total solar radiation The ratio of two components, namely diffuse radiation and total radiation represents the diffuse radiation index (DRI) or cloudiness index (Babtunde and Aro, 1995). Diffuse radiation index is an useful information particularly during *kharif* crop growing season in India. During the monsoon period, the clouds may sometimes deplete about 90% of the incoming solar radiation (Rao and Vamadevan, 1985). Such depletion of total radiation during panicle initiation in *kharif* crops like rice does affect the yield (Stansel *et al* 1965; De Datta and Zaratee, 1970).

Most of the cloud amount about 7-8 oktas (both low and medium height clouds) influence the total radiation and photosynthetically active radiation (PAR) during the season (Nathan, 1986). During ripening of the crop, it reduces the grain yield due to less percentage of spikelets being filled. Similarly high diffuse radiation causes "hopper burns" among *kharif* crops due to ammonia toxicity when the sky is overcast with heavy clouds. During this period, the stomata of plants remain closed. Nitrogen accumulates in plants and forms ammonia (Lenka, 1998).

Therefore, overcast skies with diffuse radiation particularly during flowering of rice crop, 45 days before its harvest tend to lower the grain yield (WMO, 1983). Also recent study of UNEP indicates 10% cut in the winter rice yield in the Asian region due to thick haze and cloud obscuring the sun, thus producing more diffuse radiation. So

Table 1: Average number of days with overcast sky (cloud amount ≥ 8 oktas)

Station	May	June	July	August	Sept.	Oct.	Nov.	Average
Ahmedabad	-	5	17	15	6	1	1	7.5
Mumbai	-	10	18	15	8	2	1	9.0
Kolkata	-	12	12	12	9	6	2	8.8
Chennai	-	12	7	13	10	9	9	10.0
Nagpur	-	8	17	15	9	2	1	8.7
New Delhi	-	4	7	8	4	1	0	4.0
Pune	-	9	18	5	9	4	2	7.8
Shillong	-	20	21	20	17	12	9	17.0
Thruvananthapuram	11	16	17	12	8	11	9	12.0
Visakhapatnam	5	13	17	14	12	8	4	10.0

here an attempt is made to study and understand the diurnal and monthly variation in DRI and number of days the sky was overcast, particularly during season in India.

MATERIAL AND METHOD

Data on monthly normal values of total solar radiation, diffuse radiation, cloud amount and sunshine hours were collected from the published literature of India Meteorological Department, Pune for various stations. DRI was computed on monthly basis and analysed for selected rice growing stations during kharif period. Diurnal variation of DRI and days with overcast skies were also analysed during the period. A statistical relation between sunshine hours and diffuse radiation was developed.

RESULTS AND DISCUSSION

The average number of days in a month with overcast skies for the selected stations (Table 1) shows that during July and August months, the sky is overcast with all types of clouds for nearly 20 days in a month. Shillong, in northeast India, experiences on an average 21 days of cloudiness (> 8 oktas) in a month during June to August.

DRI is found to be high (Fig.1) say >0.60 over western coast and north eastern parts of India. Locations like Chennai, Kolkatta, New Delhi, Thiruvanathapuram and Visakhapatnam have DRI values less compared to rest of the stations. The least DRI values were found in northwest India region (0.45 and less).

The diurnal variation of DRI was computed from 5 am to 8p.m. (LAT). DRI is minimum between 10 a.m. to 4p.m. for some locations (Table 2). During this period, total radiation was more than diffuse radiation. But stations like Shillong in northeast India experience high diffuse radiation during season. This location has a peak value of 0.97 in the morning, 0.54 in the forenoon and again another peak of DRI

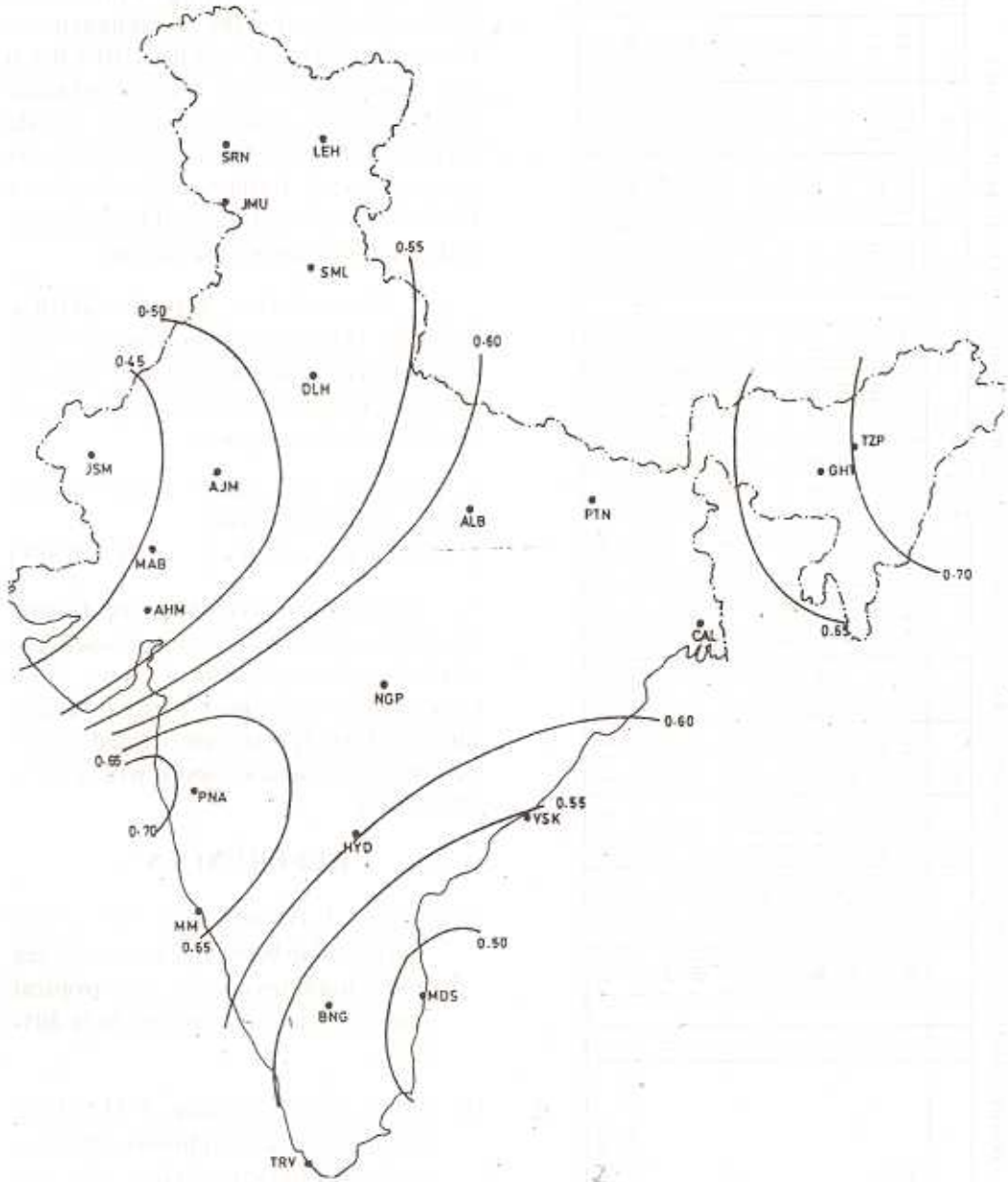

Fig. 1 : Diffuse radiation index over India (*kharif* season)

Table 2: Average diurnal variation of DRI during *kharif* season for the hours ending at: (Local apparent time)

Station	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ahmedabad	0	1.00	0.76	0.62	0.51	0.44	0.41	0.40	0.40	0.20	0.42	0.49	0.57	0.75	0.98	0
Bhavnagar	0	0.92	0.71	0.53	0.45	0.41	0.40	0.39	0.39	0.40	0.42	0.46	0.57	0.77	0.94	0
Kolkata	0	0.89	0.83	0.65	0.55	0.51	0.48	0.47	0.49	0.50	0.52	0.57	0.66	0.81	1.00	0
Goa	0	0.80	0.79	0.61	0.54	0.49	0.47	0.45	0.44	0.45	0.47	0.52	0.60	0.77	0.89	0
Chennai	0	1.00	0.80	0.60	0.93	0.48	0.46	0.45	0.46	0.48	0.50	0.54	0.57	0.74	0.87	0
Nagpur	0	0.92	0.77	0.59	0.47	0.46	0.42	0.36	0.42	0.44	0.46	0.52	0.65	0.81	0.97	0
New Delhi	0	0.77	0.94	0.68	0.54	0.48	0.45	0.44	0.43	0.45	0.48	0.54	0.65	0.87	1.00	0
Pune	0	0.90	0.78	0.61	0.53	0.48	0.46	0.45	0.46	0.49	0.49	0.53	0.61	0.76	0.86	0
Shillong	0	0.99	0.79	0.67	0.56	0.54	0.55	0.69	0.65	0.63	0.64	0.70	0.78	0.88	0.92	0
Thruvananthapuram	0	1.00	0.76	0.59	0.53	0.52	0.51	0.49	0.47	0.45	0.49	0.54	0.64	0.81	1.00	0
Visakhapatnam	0	1.00	0.73	0.59	0.51	0.47	0.46	0.45	0.45	0.45	0.46	0.50	0.59	0.76	1.00	0

0.92 late in the evening. Places like Thiruvananthampuram, Visakhapatnam, Chennai and Ahmadabad has DRI 1.0 at 6 a.m. as well as at 7 p.m. So the least value of DRI is only at near noontime. Kerala region (south west India) Visakhapatnam (in eouth east India) and in Andhara Pradesh coast are influenced by high DRI and cloudiness during the season.

The relation between diffuse radiation (y) and sunshine hours (x) over both western and eastern coast of India showed a quadratic relationship. For west coast the relationship was

$y = 245.9 + 16.76x - 3.0 x^2$ $(R^2 = 0.67^*)$

and for east coast it was

$y = 281.7\ 3.61x - 16.8 x^2$ $(R^2 = 0.55^*)$

Information like DRI, its diurnal variation, spatial variation are useful to relate biomass and yield of crops. Also more studies on hopper burns in crops, ammonia toxicity levels etc. related to high DRI or diffuse radiation levels will be more informative.

REFERENCES

Babatunde, E.B. and Aro, T.O. 1975. Relationship between clearness Index and Cloudiness index at a tropical station. *Renewable Energy*, 6(7): 801-805.

De Dattta, S.K., Zaratee, P.M. 1970. Environmental conditions affecting growth Characteristics, nitrogen response and grain yield of tropical rice. *Biometeorology*, 4: 71-89.

India Meteorological Department 1970. Normals of Hourly and Daily solar and diffuse solar radiation.

Lenka, D. 1998. Climate, weather and corps in India. Kalyani Publishers, New Delhi, p. 481

Nathan, K.K. 1986. A note on the relationship between Photosynthetically active Radiation and cloud amount. *IDOJARAS (J. Hungarian Meteorol. Ser.)*, 90 (1): 10-13.

Rao, A.S. and Vamadevan, V.K. 1985. Insolation in monsoon wet tropics and transmission /reflection coefficients of leaves of some plantation crops. *Mausam*, 36 (3): 247-350.

Stansel, J.W., Bolich, C.N., Thysell, J.R. and Hall, L. 1965. The influence of light Intensity and nitrogen fertility on rice yield components. *Rice J.*, 68(4) pp 34-35.

World Meteorological Organisation. 1983. Agricultural Meteorology CAgM Report No: 19 Guidance material for Agrometeorological Service to Rice farmers. P. 128.