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UV-B radiation in the tropical monsoon climates

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ABSTRACT

The UV-B radiation was of the order of more than one MED/hr between 10.30 a.m. and 2.30 p.m., reaching to its maximum of more than two and two-and-a-half MED/hour for about two to three hours during the peak noon hours. It crossed even more than 3MED/hr on 12.9.2002. It was high in the year 2002 when compared to that of 2003, 2004 and till June, 2005. Interestingly, the intensity of UV-B radiation was high (29.8%) in the range of more than 2MED/hr during September. Again, it was more so in the year 2002. Whether high UV values in 2002 could be due to all India drought? All the UV phenomena could be attributed to low level of ozone in addition to meteorological factors. Hence, it is suggested that protective measures round-the-year against the sun rays between 10.30 a.m. to 2.30 p.m. may be adapted to avoid the high intensity of UV-B radiation under the tropical monsoon climate since it has harmful effects on living organisms over the Earth's surface.

Key words : UV-B radiation**,** Minimum Erythema Dose, Ozone depletion

The UV radiation from the Sun is well protected by the ozone in the stratosphere at about 25 km from the Earth's surface. However, the ozone is depleted to a large extent due to human-made interventions in the industrial development since last fifty years. Reports indicate that the ozone depletion is to its low due to unusually cold stratospheric temperature and the ozone losses are caused by chlorine and bromine compounds released from chloroflourocarbons (CFCs) and halons. The annual variations of size and depth of the ozone hole depend on the variation in atmospheric conditions. Out of the three UV regions, the living organisms over the Earth's surface are more sensitive to UV-B region, ranging from 280 to 320 nanometres. It may affect the photosynthesis process in plants. Increase in the UV-B radiation may delay flowering and thereby decrease in yield according to Kulandaivelu and Amudha (2003). Ravindra Babu *et al.,* (2007) studied the diurnal and monthly UV-B radiation received at Bangalore. The UV-B radiation, if it reaches the ground, also has the potential to increase the incidence of skin cancer and cataracts in humanbeings, harm some crops and interfere with animal and marine life. The database on UV intensities and effects on different living organisms in quantitative means are not known much or scant across the world, though the harmful effects of UV-B radiation is highlighted in different media (Rao, 2005). Hence, an attempt was made to understand the diurnal profiles of UV-B radiation and the time during which the peak values are noticed so that the data can be used for various investigations in biological and agricultural fields.

MATERIALS AND METHODS

The Model 501 Version 3 UV-Biometer (Plates) was imported from M/s. Solar Light Co. INC, USA under the AICRP on Agrometeorology, ICAR in May 2002. The diurnal profiles of UV-B radiation were recorded daily for three years, commencing from June 2002 to June 2005 at the Department of Agricultural Meteorology, College of Horticulture, Kerala Agricultural University, Vellanikkara (10° 31' N; 76° 13' E and 22.5 m amsl) under the tropical monsoon climate. The UV-B solar radiometer is calibrated in such a way that the intensity of UV-B radiation between 250 to 400 nanometre was converted to Minimum Erythema Dose (MED/hr). The biological effectiveness of the UV irradiation is measured in MED/hr (Minimum Erythema Dose per hour). One MED/hr would cause minimal redness of the average skin after an hour irradiation. The integral of the cross-multiplication of irradiating flux (Wcm^{-2} nm^{-1}) and the Erythema Action Spectrum gives the Effective Power according to Mckinlay and Diffey. One MED/hr is equal to 5.83 Wcm^{-2} nm^{-1}. The statistical analysis was carried out to study the temporal variations in intensity

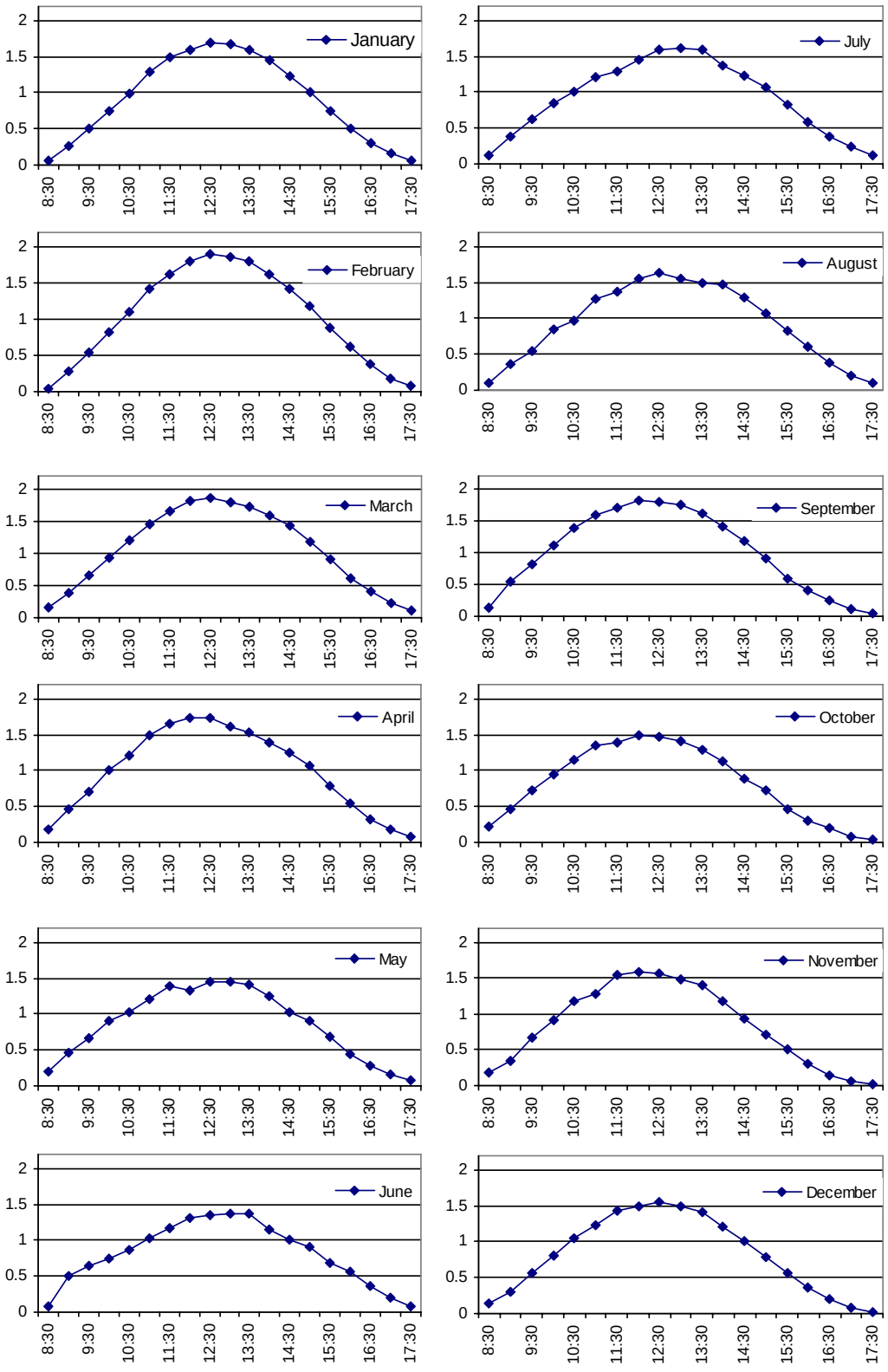

Fig.1: Mean monthly diurnal profile of UV-B radiation at Vellanikara from 2002 to 2005

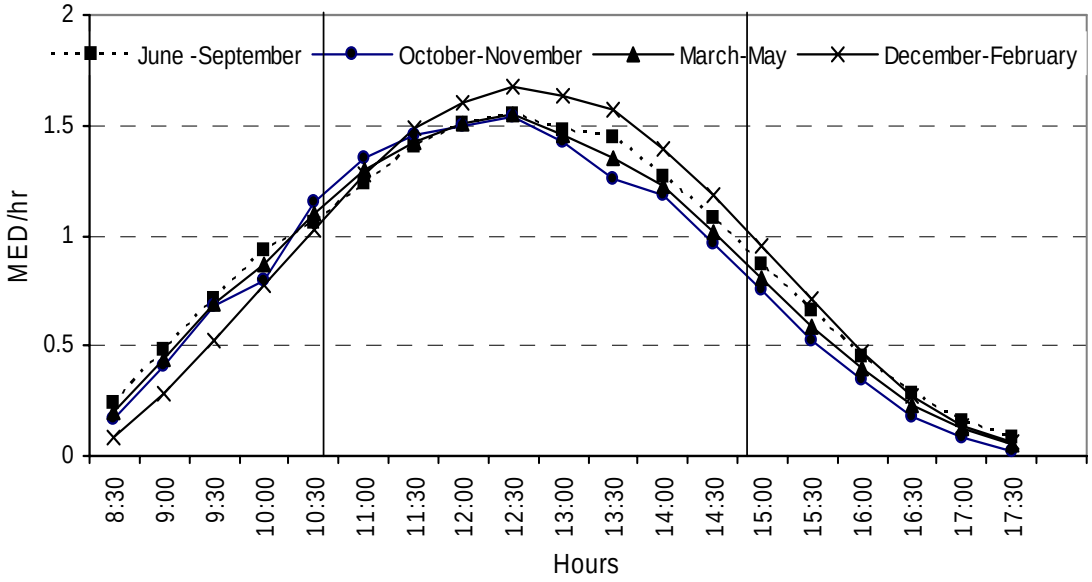

Fig.2: Diurnal profile of UV-B radiation in different seasons at Vellanikkara from 2002 to 2005

of UV- B radiation to which humanbeings, animals and plants are very sensitive.

RESULTS AND DISCUSSION

Irrespective of peak values on individual days, to infer general features, hourly values for each month have been averaged and presented in Fig.1. The mean intensity of UV-B radiation during the peak noon hours was high (>1.5 MED/hr) in January to April and September for two to three hours and for about one to two hours in July, August, November and December. In May and June, the intensity of UV- radiation was below 1.5 MED/hr. However, it was always more than 1MED/hr round-the-year up to three to four hours during the peak hours commencing from 10.30 a.m. to 2.30 p.m. It is quite interesting to note that the intensity of UV- B radiation was still further high in September during which 29.8 per cent of it fell under the category of > 2MED per hour and in the remaining months, it varied from nil (December) to 11.3 per cent in March (Table 1). At the same time, the UV-B radiation in the range of 1-2 MED/hr was seen to be between 38% in August and September and 53.4% in April followed by 51.3% in December. The high intensity of UV-B radiation during September may be attributed to the higher levels of ozone depletion for which the reasons are yet to be understood.

The mean diurnal pattern of UV-B radiation at Vellanikkara was similar irrespective of the season and it was more than one MED/hr from 10.30 a.m. to 14.30 p.m. However, it crossed beyond 1.5 MED/hr during winter (December-January) for two hours while for about one hour in the remaining seasons during peak noon hours (Fig.2). Since February is the hottest month due to high intensity of solar radiation in this part of Kerala, the same is reflected in UV-B radiation also during winter instead of summer (March-May) during which pre-monsoon showers and cloudy weather may influence the incidence of UV-B radiation and thus low during summer(Marvch-May) when compared to that of winter (December-February). It revealed that the intensity of UV-B radiation is high (>1 MED/hr) for four hours between 10.30 a.m. and 2.30 p.m. and it may adversely affect the human skin and lead to skin cancer and cataracts. Such diseases are reported increasing now-a-days and attributed to UV-B filtered radiation due to ozone depletion.

Year-to-year variation in UV-B radiation indicated that it was high (0.812-3.057 MED/hr) in September 2002. Irrespective of the season, the maximum intensity revolved between 2MED/hr and 3MED/hr (Table 2) except in 2004 from October to December. On higher side, the UV-B radiation crossed 2MED/hr, 2.5 MED/

Table 1: Month-wise intensity of UV-B radiation (%) at Vellanikkara

Month	UV-B radiation (MED/hr)		
	<1MED	1 -2MED	>2MED
January	57.5	39.7	2.8
February	40.2	49.9	9.9
March	39.8	48.9	11.3
April	40.8	53.4	5.8
May	53.7	44.6	1.7
June	49.7	47.0	3.3
July	51.4	40.8	7.8
August	52.1	37.9	10.0
September	32.2	38.0	29.8
October	53.4	39.4	7.2
November	50.4	47.4	2.2
December	48.7	51.3	0.0

Table 2: Season- wise UV-B radiation and its range from 10:30 a.m. to 14:30p.m.

Season	Year	Range
January –April	2002	-
	2003	0.290-2.565
	2004	0.136-2.358
	2005	0.055-2.636
May –August	2002	0.81-2.804
	2003	0.065-2.581
	2004	0.111-2.285
	2005	0.111-2.598
September	2002	0.812-3.057
	2003	0.902-2.458
	2004	-
	2005	0.165-2.446
tober - December	2002	0.141-2.699
	2003	0.080-2.026
	2004	0.119-1.579
	2005	0.048-2.360

hr and even more than 3MED/hr during the study period except in 2004-05 (October-December). Relatively lower values of UV were noticed from October to December and it was more so in 2004 (0.119-1.579 MED/hr). These annual variations could be attributed to the ozone fluctuations. It was a coincidence that the high UV radiation during the monsoon 2002 might be due to deficit monsoon rainfall and it was declared as the All India drought year. The monsoon rainfall deficit was of the order of 19% across the country. The rainfall deficit during July 2002 was the highest (49%). In Kerala, the deficit rainfall during monsoon 2002 was 35%.

Polly Curtis (2005) reported that the closer you get to the equator, the higher the incidence of skin cancer among light skinned people, but that the reverse is true of other types of cancer. It is also understood that under protected cultivation with UV stabilized low-density polyethylene (UVLDPE) film of 200 micron thickness, the performance of vegetable crops was much better and relatively disease free with superior quality when compared to that of open and other protected material in greenhouse cultivation, according to Indira *et al* (2004). However, detailed studies are to be undertaken across the world to understand the ill-effects of UV-B radiation on various biological fields in the tropical, sub-tropical and temperate regions.

CONCLUSION

The UV-B radiation was of the order of more than one MED/hr between 10.30 a.m. to 2.30 p.m., reaching to its maximum of more than two and two-and-a- half MED/hr for about two to three hours during peak hours. It crossed even more than 3MED/hr on 12.9.2002. In contrast to the high intensities of radiation in February, March and April, the intensity of UV-B radiation was high (29.8%) in the range of more than 2 MED/hr during September also, when compared to remaining months. It was more so in the year 2002. Whether it could be attributed to all India drought 2002? There was an indication that the UV radiation recorded on cloudy day was also high (>1.5 MED/hr) during peak noon hours occasionally though it was always less than one MED/hr on majority of the cloudy days. Hence, it is suggested that protective measures round-the-year against the sun rays between 10.30 a.m. and 2.30 p.m. may be adapted to avoid the high intensity of UV-B radiation due to ozone depletion under the tropical monsoon climate since it has harmful effects on living organisms over the Earth's surface. With continuous irradiation for more than 2MED/hr, the human skin may turn black as per the definition of MED. Beyond three hours, skin may burn as indicated by the World Meteorological Organisation.

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