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Radiation balance components in a finger millet (*Eleusine coracana*) crop

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सार — इस शोध पत्र में रागी की फसल में विकिरण बजट के अवयवों के अधिकतम तथा न्यूनतम मान दिये गए हैं। विभिन्न अवयवों तथा फसल बोने की अवधि में भूमण्डलीय विकिरण के बीच अनुपातों में परिवर्तन पर इस शोध पत्र में चर्चा की गई है।

ABSTRACT. Maximum and minimum values of components of radiation budget in a millet crop are presented. Variation of the ratios between the various components and the global radiation during the crop growing period is discussed.

1. Introduction

Plants respond to instantaneous values of incident solar radiation and maximum values during a daily cycle can be critical to plant processes. Incident solar radiation integrated over long periods influences cumulative effects such as water usage, storage of sugars and growth of plants. Also incident solar radiation influences directly plant temperatures which in turn govern the rates of biochemical processes within the plants. Albedo is of much importance in determining the radiation balance of a crop stand. Apart from determining the amount of solar radiation absorbed by the crop, it also influences the terrestrial flux emitted by the crop since the absorbed solar radiation directly influences the temperature of the crop surface. Net radiation is the main parameter in several methods of estimating evapotranspiration. Detailed information regarding the radiation balance components can be of much help in understanding the various physical and physiological processes taking place in a crop stand.

Solar radiation incident on the earth's surface varies from place to place and hence components of radiation balance obtained in one place cannot be directly compared with values obtained at other places. To some extent this difficulty can be overcome by deriving ratios of net solar, terrestrial and net radiation fluxes to the total solar radiation. Some such ratios have been reported by Stanhill *et al.* (1966). In the present paper seasonal variations of the ratios of radiation balance components to the incident solar radiation in a finger millet (*Eleusine coracana*) crop are presented. This study is a part of an energy budget investigation carried out by the author in the Sugarcane Research Station at Anakapalle (17 deg. 40′N, 83 deg. 02′E). Canopy resistance of the crop and soil heat flux within the crop have been reported earlier (Karuna Kumar and Subrahmanyam 1978, Karuna Kumar 1978).

2. Materials and methods

The experiments were conducted in a field of Ragi AKP-2 crop. The twenty day old seedlings were transplanted in a 1.15 ac field on 1 June 1977 and the crop was harvested on 5 August 1977. The crop was raised under irrigated conditions and three irrigations were applied between transplantation and harvesting of the crop. The incident reflected short-wave radiation fluxes were measured by means of an Eppley pyranometer. Net radiation was measured by means of a net pyrradiometer (Fuke type). Both the instruments were attached to iron masts and were always maintained at height of one metre above the crop surface. In the case of the Eppley pyranometer arrangement was also made to keep the instrument in both upright and inverted positions. About 90 per cent of the upward radiation fluxes received by the instruments was from a circular area of the crop having a radius of three metres. The net solar radiation in each hour was obtained by subtracting the reflected solar radiation from the incident solar radiation. Similarly, net terrestrial radiation in each hour during daytime was obtained by subtracting net solar radiation from net radiation. During night time measured net radiation values represent the net terrestrial radiation directed upward from the crop surface. Measurement of the net radiation components was carried out throughout the season excepting on rainy days.

3. Results and discussion

Variation in albedo between transplantation and harvest is shown in Fig. 1(a). During the first week after transplantation it was around 16.5 per cent. During this period the soil was covered only to a small extent by the crop. From then onwards reflectivity increased very slowly with increase in leaf-area-index. During the period 25 June 1977 to 12 July 1977 reflectivity was high, the daily values ranging from

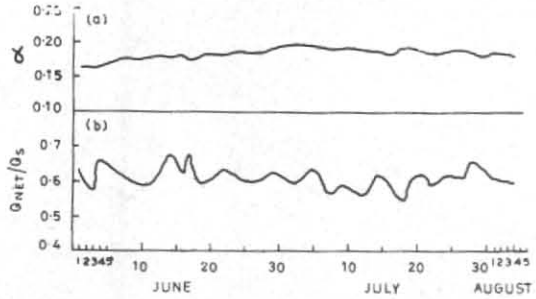

Fig. 1(a-b). Variation of (a) albedo (α) and (b) ratio between daily net radiation and global radiation (Q/G)

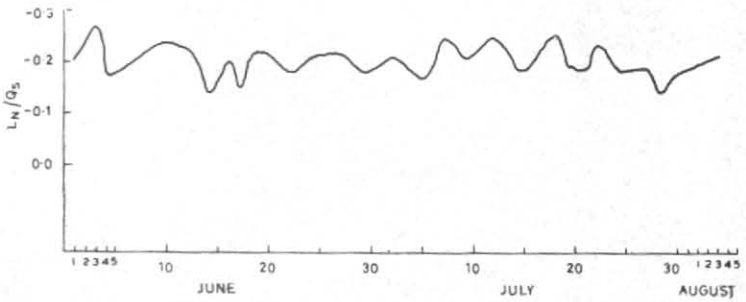

Fig. 2. Variation of the ratio between daily net terrestrial radiation and global radiation (L/G)

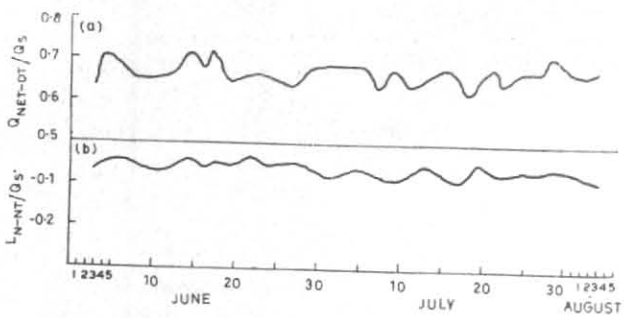

Fig. 3(a-b). Variation of(a)ratio between daytime net radiation and global radiation (Q_{DT}/G) and(b)ratio between daytime net terrestrial radiation and global radiation ($L_{DT}*/G$)

18.2 to 19.5 per cent. No influence of flowing or seed-setting on the value of reflectivity was noticed. From 12 July 1977 to 3 August 1977 small fluctuations in the daily reflectivity values were observed. In general, reflectivity values towards the end of the season were slightly lower than values observed between 25 June 1977 and 12 July 1977. Similar features are found when the mean reflectivity values for weekly periods are considered (Karuna Kumar 1979). Lowest value of 16.64 per cent is obtained for the first week. High values are noticed during 5th, 6th and 7th weeks when the leaf-area and dry matter increased steeply. Slight decrease in mean albedo value during the last two weeks is associated with decrease in leaf-area-index. The mean albedo for the entire season was 18.26 per cent. A value of 19.0 per cent was reported by Kassam and Kowal (1975) for a gero millet crop at Samaru, northern Nigeria.

Maximum daily net terrestrial radiation observed was 154.37 langleys and the minimum value was 35.18 langleys. Ratio of daily net terrestrial radiation to global radiation varied from 26.7 to 14.1 per cent (Fig. 2). Mean values of the ratio $L*/G$ for weekly periods are considered and relatively high values were noticed during the first two weeks after transplantation when the crop cover and soil moisture contents were low. Between 20 June 1977 and 7 July 1977 there was appreciable increase in leaf-area-index and dry matter production. Values of the ratio $L*/G$ during the 4th and 5th weeks were slightly lower than values for the first two weeks. During the period 7 July 1977 to 22 July 1977 there was rain on only four days and cloudiness was relatively small. As a result, high values of the ratio $L*/G$ were noticed during the 6th and 7th weeks. From 23 July 1977 to 4 August 1977 there was much cloudiness and the mean duration of bright sunshine was 2.34 hours as compared with 6.88 hours during the preceding two weeks. Consequently values of the ratio during the last two weeks were much lower than the values during the 6th and 7th weeks. Seasonal mean of the ratio $L*/G$ was 20.97 per cent.

Maximum and minimum values of daytime net terrestrial radiation observed were 110.20 (18 July 1977) and 22.40 (9 July 1977) respectively. The ratio between daytime net terrestrial radiation and global radiation (Fig. 3b) ranged between 0.196 and 0.094.

Maximum and minimum values of daytime net radiation observed were 411.83 langleys and 119.02 langleys respectively. Ratios of daytime net radiation to global radiation are given in Fig. 3(a). The ratio varied from 62.0 to 72.2 per cent. The variation was found to be related to cloudiness and to a much smaller extent, to soil moisture availability. No influence of crop growth on the ratio could be noticed. From transplantation to harvest the mean value of the ratio was 66.56 per cent. Kassam and Kowal (1975) obtained a seasonal mean value of 62.12 per cent for the gero millet crop at Samaru.

Daily net radiation ranged between 385.09 langleys and 103.54 langleys. Variation in the ratio of daily net radiation to daily global radiation is shown in Fig. 1(b). The variation in the ratio integrates the variations in the other net radiation components mentioned above and was from 68.2 to 54.56 per cent. Mean value of the ratio between transplantation and harvest was 60.77 per cent.

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