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Water loss and canopy resistance to water flow from sunflower (*Helianthus Annus* L) in two different climatic environments

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सार — प्रस्तुत शोध-पत्र में, खरीफ और रबी की फसल के दौरान सूरजमुखी के प्रतिरोधी वितान में जल ह्रास और उसकी विभिन्नता का विश्लेषण किया गया है।

रबी की फसल में सूरजमुखी में दैनिक जल का औसत ह्रास खरीफ की तुलना में थोड़ा सा कम पाया गया है। मिट्टी सूखने के कारण यथेष्ट मात्रा में जल का ह्रास हो जाता है। 0-45 सें.मी. की गहराई तक मिट्टी की परतों में, नमी की मात्रा के साथ जल का ह्रास उल्लेखनीय रूप से सम्बद्ध है। जब मिट्टी गीली होती है तो वितान प्रतिरोध स्पष्टतः कम होता है। किन्तु जैसे-जैसे मिट्टी सूखती है, उसकी प्रतिरोधकता बढ़ती जाती है।

ABSTRACT. In the present paper water loss and variations in canopy resistance in sunflower during kharif and rabi have been analysed.

Mean daily water loss of sunflower in rabi season is slightly less than that in kharif. The water loss falls considerably as the soil dries down. The soil water loss is found to be significantly correlated with moisture content in 0-45 cm depth soil profile. The canopy resistance is fairly low when the soil is wet but as soil dries, the resistance increases.

Key words — Canopy resistance, Dry cycle, Evapotranspiration.

1. Introduction

Consumptive use of a crop is an important factor in estimating water requirement for planning irrigation systems. Weekly and seasonal evapotranspiration of crops vary over a wide range depending on the climatic environment and soil conditions of the region. It is a well accepted fact that the various crop development stages possess varying sensitivity to moisture availability (Doorenboss and Kassam 1979). Sunflower is one of the important oilseed crops of India. In dry farming tracts of India, where sunflower is normally grown, precipitation is generally less than the water demand for most part of the growing season.

The objective of this paper is to report on the dynamics of inputs and outputs of water for the sunflower crop in a semi-arid region of India.

2. Data

The study pertains to Bangalore (12° 57'N, 77° 38' E) which has a semi-arid climate. Data of KBSII-II variety of sunflower cultivated during 1991 in rabi (Jan-Apr) and kharif (Jul-Oct) seasons were used. All meteorological observations have been recorded at the experimental field, adjoining observatory.

3. Methods of analysis

Daily values of Evapotranspiration (ET) were used to determine frequency distribution of water loss.

Potential evapotranspiration (PET) was calculated using modified Penman's method (Doorenboss and Pruitt 1975). Canopy resistance to water flow was calculated using the following equation (Monteith 1963):

$$r_c = \epsilon\, \rho\, (e_a - e_s)/P \times E \qquad (1)$$

where, E = observed water loss rate (g cm^{-2} s^{-1})

e_a = vapour pressure (hPa) over the leaf surface

e_s = observed vapour pressure (hPa) at 150 cm height

r_c = canopy resistance (s cm^{-1})

ρ = density of air (g cm^{-3})

ϵ = the ratio of the molecular weight of water vapour to the molecular weight of air taken as 0.622

and P = atmospheric air pressure (hPa).

Change in daily ET and the ET/PET were plotted as functions of time. Diurnal variations in r_c for selected days have also been studied.

4. Results and discussions

4.1. *Seasonal water loss*

PET were normally distributed in both the seasons. During rabi season, occasions of PET > 6 mm/day were 35% while PET rates < 3 mm/day were negligible. The PET rates during the kharif season were comparatively lower than those in the rabi season. During the rabi season over 35% of the water loss events were of less than 2 mm/day, while in kharif season such occasions were nearly 15%. The mean ET was 2.2 and 3.1 mm per day during the rabi and kharif seasons respectively. It was seen that daily rainfall less than 5 mm/day contributed only 10% of the total rainfall. Since the average potential water loss rate during growing season is greater than 5 mm/day, most of the water added during low precipitation days gets evaporated within a few days and thus contributes very little to soil water recharge. Meinke *et al.* (1993) studied potential soil water extraction by sunflower on a wide range of soil and showed that available water to the crop vary with the soil type.

4.2. *Weekly water loss*

The maximum water loss was seen on 6th week after sowing in the rabi season. After the stress period on 8th week, irrigation increased the ET which attained a value of 3 mm/day on the 10th week. During kharif season, the ET value increased gradually from the beginning, attaining a peak of 3.8 mm/day on the 12th week and subsequently decreased. The ET/PET ratio during the rabi season indicated stress periods during elongation and flowering stages. The ratios during kharif season were comparatively higher than during the rabi season.

4.3. *Dry-down curves*

The mean ET loss and ratio of ET to PET as a function of time from the date of water input for 7 subsequent dry days, have been computed. For this purpose water input events were categorised as large (> 15 mm/day), medium (between 15 and 5 mm) and small (< 5 mm/day). The analysis for both rabi and kharif seasons revealed that the ET/PET ratio (Y) decrease exponentially with time (t) as revealed by the following regression equations for each of the three water input events:

(a) *Rabi season*

(*i*) Large events

$$Y = 0.60\ e^{-0.13t} \qquad (R^2 = 0.77)$$

(*ii*) Medium events

$$Y = 0.79\ e^{-0.13t} \qquad (R^2 = 0.86)$$

(*iii*) Small events

$$Y = 0.92\ e^{-0.09t} \qquad (R^2 = 0.85)$$

(b) *Kharif season*

(*i*) Large events

$$Y = 0.69\ e^{-0.17t} \qquad (R^2 = 0.69)$$

(*ii*) Medium events

$$Y = 0.81\ e^{-0.11t} \qquad (R^2 = 0.86)$$

(*iii*) Small events

$$Y = 0.97\ e^{-0.08t} \qquad (R^2 = 0.81)$$

Comparison of the co-efficients in the equations

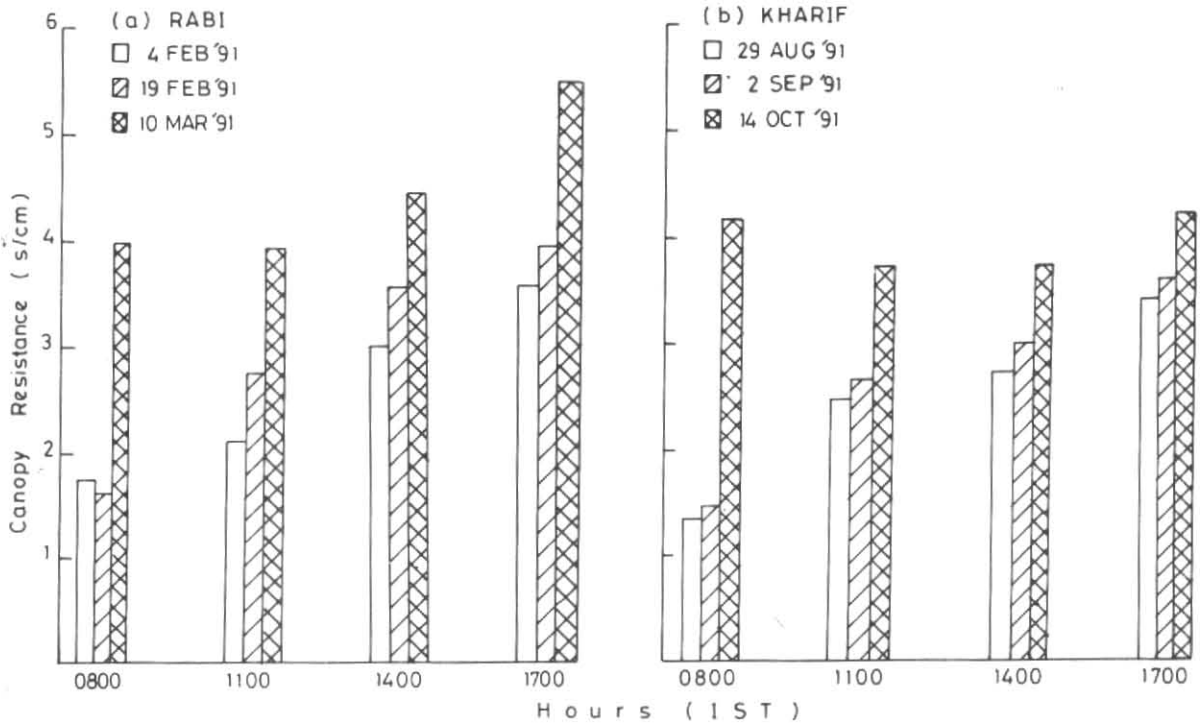

Fig. 1 (a&b). Diurnal change of canopy resistance (r_c) for selected days

for rabi season suggests a decrease in the ratio at identical rates for large and medium water input events and a slow decrease for the small event. For kharif season, decrease rate for large water input events was more rapid.

The water loss (ET) for both the crop seasons decreased rapidly during first 3 days. During rabi, the decrease in water loss rate for large, medium and small rainfall event was 0.54, 0.51 and 0.00 mm/day respectively.

4.4. *Water loss in relation to soil moisture*

Soil water content in 0-45 cm soil profile and daily water loss for both rabi and kharif seasons, were found significantly correlated with correlation co-efficients respectively being 0.75 and 0.78. The relationships for the other depths, *i.e.*, 0-15, 15-30, 30-45 and 0-30 cm were however found to be insignificant. This was perhaps because factors such as bare soil water loss, distribution of soil water etc. were not considered in the analysis. Rachidi *et al.* (1993) found that sunflower can extract more water at somewhat deeper soil depths compared to other crops and suggested that sunflower might be planted in rotation with shallow rooted crops to take advantage of water at greater depth.

4.5. *Canopy resistance*

In this study three hourly change in canopy resistance (r_c) was computed for three selected days each in rabi and kharif season. During the rabi season [Fig. 1 (a)], the soil drying during 4 February and 19 February caused resistance to increase from 1.5 to 3.5 s/cm with higher values noticed during afternoon hours and on 10 March the resistance increased upto a maximum value of 5.5 s/cm at 1700 hr. During the kharif season [Fig. 1 (b)], the magnitude of the resistance is comparatively smaller which may be attributed to the more soil moisture availability during the period. The large increase in r_c to water flow in drier soils is a result of high soil hydraulic resistance that restricts the plants'ability to meet potential water loss. As the soil water content starts decreasing, the resistance increases.

Ripley and Saugier (1978) found that r_c for native grass ranged between 1 and 2 s/cm with sample soil water, but with drier soil, r_c assumed values greater than 14 s/cm. Parton *et al.* (1981) also found that r_c varies between 2 and 3 s/cm with high soil water content and with dried soil r_c increased to a more than 20 s/cm.

5. Conclusion

The daily water loss in kharif is found about 1.0 mm more than that in rabi. The water loss is generally rapid immediately after water input events and decreases gradually during the subsequent drying cycle. The canopy resistance to water flow increases as the day progresses.

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