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# Biomass production in wheat in relation to evaporative demand and ambient temperature

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सार - जैवमात्रा का उत्पादन गेहूं की उगाई जाने वाली 3 किस्मों में सिंचित भूमि में कुछ अवसीमा मान के ऊपर संचयी वाष्पन और संचित ऊष्मा इकाइयों में रैखिक संबंध पाया गया है । जैवमात्रा का उत्पादन संचयी वाष्पन और संचित उष्मा के विभिन्न स्तरों का आकलन करता है । क्षेत्र विशेष में वाष्पन की मांग और ताप क्षेत्र के बारे में अनेक किस्म की प्रतिक्रियाओं का गुणात्मक अनुमान करने के लिए इस सूचना को उपयोग में लाने की संभावनाएं दृष्टिगोचर होती हैं ।

ABSTRACT. Biomass production in 3 varieties of wheat grown under irrigated field conditions was found to be linearly related to cumulative evaporation and accumulated heat units above certain threshold value. Biomass production estimates at different levels of cumulative evaporation and accumulated heat indicated the possibility of using this information for a qualitative assessment of varietal response to evaporative demand and thermal regime prevailing in the region.

## 1. Introduction

Cummulative evapotranspiration has been reported to be highly correlated with plant biomass production. Viets (1962) observed that even when the biomass production increased linearly with evapotranspiration, the regression line seldom passed through the origin. Evidently, the linear relationship becomes valid after sufficient evapotranspiration has occurred for crop establishment in initial stages as indicated by experiments of Allison *et al.* (1958) and Hanks *et al.* (1968).

Accumulated heat (degree days) is another factor that had been shown to be linearly correlated with dry matter production in soybean crop by Hanway and Weber (1971) and Uchijima (1975). This follows the premise that plants cumulative evaporation and accumulated heat energy before they attain the different phenological stages. However, in case of wheat crop the relationship between accumulated heat and biomass production does not appear to have been much studied. In this paper, biomass production pattern of three wheat varieties in relation to cumulative evaporation and accumulated heat evaluated from the field experiments conducted at the Indian Agricultural Research Institute, New Delhi is reported and its utility in assessment of varietal response to atmospheric demand and thermal regimes is examined

## 2. Materials and methods

Three varieties of wheat (Triticum aestevum, L.) namely, Kalyansona, HD-2160 and Sonalika were raised on sandy loam soils under irrigated conditions during the winter seasons 1978-79 and 1979-80 in a randomized block design with triplicate plots of size 5 $\times$ 6 m. Three dates of sowing were used in both the seasons and the crops were sown on 24 November, 4 December and 14 December respectively.

*Plant biomass* — Above-ground plant material oven dried at 80 deg. C to constant weight were used for determining biomass production at weekly intevals. The samples consisted of plants from 50 cm length taken from two rows leaving two border rows in each plot.

*Cumulative evaporation* — Daily values of evaporation from a class A type wire mesh covered pan evaporimeter as per the specifications of the India Meteorological Department were collected. Daily values were cumulated over the cropping season for the different treatments to obtain cumulative evaporation at every stage of sampling of plant biomass.

*Accumulated heat units* — A base temperature of 5 deg. C was used following Nuttonson (1955) for computing the accumulated heat units (growing degree days) with reference to mean air temperature. Maximum and minimum temperatures were recorded using a Stevenson screen erected near the experimental site.

For computing regression between weekly biomass production and cumulative evaporation or accumulated heat units, data for the three plantings for the two seasons for each variety and for the 10 plant samplings were pooled and thus the population for correlation consisted of sixty values for each variety.

## 3. Results and discussion

### 3.1. *Atmospheric demand and biomass production*

The correlations and regression equations between cumulative pan evaporation (CPE) and biomass production (g/m²) for the 3 varieties are as follows :

| *Variety* | *Correlation coefficient* | *Regression* |
|---|---|---|
| Kalyansona | 0.87*** | $Y_K = 6.0\ CPE - 472$ |
| HD-2160 | 0.89*** | $Y_H = 5.9\ CPE - 462$ |
| Sonalika | 0.94*** | $Y_S = 6.7\ CPE - 598$ |

where, CPE refers to cumulative pan evaporation in mm.

$Y_K$, $Y_H$ and $Y_S$ are biomass in g/m²

***significant at $P<0.001$

The correlations were found to be highly significant. Similar significant correlations were reported by Arkley (1963) and Hanks *et al.* (1969) in wheat, oats and barley crops. In view of the high correlations obtained, using the above regressions, biomass production at different levels of cumulative evaporation for each of the 3 varieties was computed and shown in Table 1. Of the three varieties studied, it is seen that biomass production after accumulation of 200 mm of evaporation corresponding to completion of vegetative stage in respect of variety Sonalika was the highest followed by Kalyansona and HD-2160. The latter two varieties yielded the same amount of biomass at different levels of cumulative evaporation.

### 3.2. *Growing degree days vs biomass production*

The correlation and regression equations between the accumulated heat units and biomass production in respect of the three wheat varieties are given below :

| *Variety* | *Correlation coefficient* | *Regression* |
|---|---|---|
| Kalyansona | 0.95*** | $Y_K = 1.82\ GD - 928$ |
| HD-2160 | 0.94*** | $Y_H = 1.71\ GD - 817$ |
| Sonalika | 0.95*** | $Y_S = 1.89\ GD - 951$ |

GD — growing degree days from sowing

***significant at $P<0.001$

$Y_K$, $Y_H$ and $Y_S$ are biomass in g/m²

TABLE 1

**Biomass production in wheat at different levels of cumulative evaporation**

| Cumulative evaporation (mm) | Biomass production ($g/m^2$) variety | | |
|---|---|---|---|
| | Kalyansona | HD-2160 | Sonalika |
| 100 | 128 | 128 | 72 |
| 120 | 248 | 246 | 206 |
| 140 | 368 | 364 | 340 |
| 160 | 488 | 482 | 474 |
| 200 | 728 | 718 | 742 |
| 240 | 968 | 954 | 1010 |
| 280 | 1208 | 1190 | 1278 |
| 300 | 1328 | 1308 | 1412 |
| 350 | 1628 | 1603 | 1747 |

TABLE 2

**Biomass production in wheat at different levels of accumulated heat**

| Accumulated heat (growth degree days above 5 °C) | Biomass production ($g/m^2$) variety | | |
|---|---|---|---|
| | Kalyansona | HD-2160 | Sonalika |
| 600 | 164 | 209 | 183 |
| 700 | 346 | 380 | 372 |
| 800 | 528 | 551 | 561 |
| 900 | 710 | 722 | 750 |
| 1000 | 892 | 893 | 939 |
| 1100 | 1074 | 1064 | 1128 |
| 1200 | 1256 | 1235 | 1317 |
| 1300 | 1438 | 1406 | 1506 |
| 1400 | 1620 | 1577 | 1695 |
| 1500 | 1802 | 1748 | 1884 |

The correlations of biomass with accumulated heat units were highly significant. Using the regression, biomass production at different levels of accumulated heat was estimated and shown in Table 2. As observed earlier in respect of cumulative evaporation, in this case also, variety Sonalika showed the highest biomass production for a given level of accumulated heat followed by Kalyansona and HD-2160. As an illustration, on accumulation of 1000 degree days, the biomass production of Kalyansona, HD-2160 and Sonalika were 892, 893 annd 939 $g/m^2$ respectively revealing the highest energy use efficiency by variety Sonalika.

The intercepts for biomass production evaluated from the regression showed that about 35 days are needed for crop establishment for the linear relationship to be true between biomass and cumulative evaporation/accumulated heat, corresponding to 82 mm of evaporation and 497 degree days respectively.

The results presented above not only confirm the linear relationship between evaporative demand and biomass production observed by earlier workers (Hanks *et al.* 1969) but also reveal a linear relationship between accumulated heat units and biomass production in wheat, on which available reports are meagre. The results on biomass production at different levels of accumulated heat and cumulative evaporation indicate the possibility of using the regressions for relative assessment of varietal response to prevailing atmospheric demand representing potential water requirements and the prevailing thermal regime which should prove useful in crop planning as an additional tool.

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