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Effect of Weather Parameters on Biomass Production in Pigeonpea

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Abstract An experiment was conducted for developing response functions between biomass production and growing degree days and evaporation in pigeonpea (*Cajanus cajan* L. Mill sp.), cultivars H-80-110, UPAS-120 and Manak with four dates of sowing (5 and 20 June, 5 and 20 July) at Research Farm of Haryana Agricultural University, Hisar, during *kharif* seasons of 1987 and 1988. Simple linear, logarithmic, exponential and multiple linear response functions were studied, which are presented in the text. The regression model of the form $y = a + b x + c x_1$ (y – dry matter g plant^{-1}; x – growing degree days and x_1 – evaporation) was the most satisfactory and can be used for prediction of dry biomass.

Key words Linear, logarithmic, exponential, regression, pigeonpea.

Pigeonpea commonly known as *arhar*, is an important pulse crop of India and ranks second to gram in area. The time of sowing is most important factor which influences the balance between vegetative and reproductive phases and ultimately the yield. In earlier studies (Akinola & Whiteman 1975, Ahlawat *et al.* 1975, Faroda & Singh 1977, Dhingra *et al.* 1980) it was revealed that phenophases and yield varied with different sowing dates but no research work has been done with respect to weather parameters, responsible for these variations. Chakravarty & Sastry (1983) studied the simple relationship between dry matter production and cumulative heat units in mung bean. Various relationships have been attempted in this study for expressing biomass production in terms of the weather parameters like growing degree days (GDD) and pan evaporation (Ep).

Materials and Methods

Field experiments were conducted at research farm of Department of Agricultural Meteorology, Haryana Agricultural University, Hisar (Latitude 29°10'N, Longitude 75°46'E, Altitude 215.2 m), during *kharif* seasons of 1987 and 1988. There were four dates of sowing (June 5, 20, July 5 and 20) and three pigeonpea cultivars (H-80-110, UPAS-120 and Manak). All the treatments were replicated thrice in a randomized block design. The soil of the experimental field was sandy loam. The biomass observations were recorded once the plants were established, and subsequently at 15 day interval upto crop maturity. A total of thirteen biomass observations, six in 1987 and seven in 1988, were taken. Samples were taken randomly from each field. Dry weight was determined after oven drying. Maximum and minimum temperatures and open pan evaporation (mm) by US Class A-type pan evaporimeter were recorded at an observatory located about 100 metres from the field. The GDD was calculated by using a base temperature of 10°C. Degree days were computed from the date of sowing to each day of observation, for each experiment. Similarly, accumulated evaporation was computed corresponding to each biomass obser-vation from each date of sowing for both the years. Data of both the years, for all dates of sowing and varieties, were pooled to develop response functions between the accumulated dry biomass with GDD and pan evaporation of the form of :

$$y = a + b x; \quad y = a + b \log x$$
$$\log y = a + b x; \quad \log y = a + b \log x$$
$$y = a + b x + c x_1$$

where,

y = accumulated biomass production (DM)

x, x_1 = GDD, E_p

a = constant

b, c = regression coefficients

Results and Discussion

Cumulative pan evaporation and GDD explained the dry biomass production upto 78 and 86 per cent, respectively. These were highly significant as F values were 28.50 and 129.91 against tabulated value 6.96 at $P<0.01$. Similar linear relationships were reported by Hanks *et al.* (1969), Doyle & Fisher (1979) for wheat crop and Chakravarty & Sastry (1983) for mung bean.

The response function (log y = a + b x) between dry biomass production and GDD and E_p was significant and explained dry biomass variations upto 75 and 83 per cent, respectively, with significant F values of 21.42 and 88.33 which are higher than the tabulated value 6.96 at $P<0.01$. Similar functions were also reported by Ganesan *et al.* (1988) in *rabi* crop.

The response function (log y = a + b log x) between DM and GDD and Ep explained with greater accuracy than log y = a + b x as shown in Table 1. The calculated F values were also higher than tabulated F values 6.96 at $P<0.01$.

Significant relationships were also observed between DM and GDD and Ep in y = a+b log x expression, explaining 78 and 86 per cent variation, respectively, with F values of 68.65 and 179.75 much higher against tabulated value (6.96 at $P<0.01$). This form of relationship explained in better way the variations in dry biomass production with use of GDD and Ep and R^2 values were higher than in other above mentioned relationships. Biomass production was linear multiple function of cumulative GDD and evaporation parameters.

$$DM = -65.99 + 0.012\,GDD + 0.154\,E_p$$

$$R^2 = 0.93$$

This relationship was best among the above discussed relationships as R^2 values were higher and highly significant (F value 4.82 at $P<0.01$).

It is concluded that multiple regression of the form DM = a + b GDD + c Ep is most satisfactory in explaining 93 per cent variation in dry biomass. The evaporation explained variation in dry biomass in a better way than GDD.

Table 1 *Response function of dry matter (DM) with weather parameters in pigeonpea*

Parameters	Response functions	R^2
	$y = a + bx$	
GDD	$DM = -38.598 + 0.059\,GDD$ (7.84)	0.78
Ep	$DM = -74.521 + 0.161\,E_p$ (10.71)	0.86
	$\log y = a + bx$	
GDD	$\log DM = 1.176 + 0.075\,GDD$ (5.44)	0.75
Ep	$\log DM = 1.170 + 0.07\,E_p$ (5.56)	0.83
	$\log y = a + b \log x$	
GDD	$\log DM = -17.119 + 3.10 \log GDD$ (5.025)	0.79
Ep	$\log DM = -9.828 + 1.87 \log E_p$ (8.081)	0.88
	$y = a + b \log x$	
GDD	$DM = -810.6 + 105.43 \log GDD$ (7.52)	0.85
Ep	$DM = -933.0 + 133.58 \log E_p$ (12.81)	0.92

References

Ahlawat IPS, Saraf CS & Singh A 1975 Studies on the performance of pigeonpea varieties to dates of planting and row spacing. *Indian Journal of Agronomy* **20** 245-247

Akinola JO & Whiteman PC 1975 Agronomic studies on pigeonpea (*Cajanus cajan* L. Mill sp.) I. Field response to sowing time. *Australian Journal of Agricultural Research* **26** 43-56

Chakravarty NVK & Sastry PSN 1983 Biomass production in moong (*Vigna radiata* L. Wilezek) in relation to pan evaporation and ambient temperature. *Agricultural Meteorology* **29** 57-62

Dhingra KK, Singh S & Tripathi HP 1980 Phenological behaviour and yield of pigeonpea (*Cajanus cajan* L. Mill sp.) genotypes under different dates of planting and row spacing. Paper presented at *International Workshop on Pigeonpea* held at ICRISAT from December 15-19, 1980

Doyle AD & Fisher RA 1979 Dry matter accumulation and water relations in wheat crops. *Australian Journal of Agricultural Research* **30** 815-829

Faroda AS & Singh RC 1977 Date of planting, row spacing and varietal trial on arhar. *Report on Kharif Pulses,* Department of Plant Breeding, Haryana Agricultural University, Hisar. pp. A33-A34

Ganesan GS, Ahobala Rao HR & Mathurbutheswaran G 1988 A study of the influence of selected weather parameters on biomass production in ragi. *Mausam* **89** 197-200

Hanks RJ, Klute A & Bressler E 1969 A numeric method for estimating infiltration, redistribution, drainage and evaporation of water from soil. *Water Resources Research* **5** 1064-1069

Ong CK 1983 Response to temperature in a stand of pearl millet (*Pennisetum typhoides* S. & H.) I. Vegetative development. *Journal of Experimental Botany* **34** 1731-1739