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Statistical crop weather model to predict the grain yield of fingermillent *(Eleusine coracana)*

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ABSTRACT

A multiple linear regression equation is developed using agrometeorological variables such as growing degree days (GDD), sunshine hours (SSH) and actual *evapotranspiration* (AET) and the grain yield of fingermillet which was raised in *Kharif* season during the year 1992 – 1998 under rainfed condition, taking all the important crop phenological stages together. R^2 was high (0.97) with a good agreement between the predicted and observed yield. A greater influence of AET at the time of ear emergence stage on the grain yield was observed. Higher GDD is not favorable during tillering but favorable at all other stages. Grain yield during the year 1999 was predicted in advance and found satisfactory (95 per cent).

Key words : Reqression equation, crop weather model, Finger-millet

Crop weather models have become tools to modern agriculture to simulate crop yield well before harvest. Statistical crop weather model is one of the crop weather models wherein the influence of weather on the performance of the crop in each stage is studied. Number of attempts were made earlier. Gregory (1926), Victor *et. al.* (1991 a, b), Parthasarathy *et. al.* (1988), Nathan (1996), Rajesh Kumar *et. al.* (1999), to relate weather parameters with crop yield. Ganeshan *et. al.*, (1989) have reported that the light interception at the time of flowering does not have any significant correlation either cumulative or mean weather parameter in case of fingermillet.

An attempt is made here to develop a suitable statistical crop weather model to study the influence of growing degree days (GDD), sunshine hours (SSH) and actual evapotransiration (AET) on crop growth in each of the phenological stages and to predict the final grain yield of fingermillet crop raised at Gandhi Krishi Vijnana Kendra (GKVK) (Altitude 930 m above mean sea leavel, longitude 77°35' and latitude 12°58') at Bangalore, Karnataka.

MATERIALS AND METHODS

Field experiments were laid out in *Kharif* season during the years 1992-98 GKVK and finger millet was raised under rainfed condition on red sandy loam soils following recommended package of practices. Each year the crop was rotated with a leguminous crop, groundnut. Meteorological data from the adjacent observatory were used. GDD has been worked keeping 10°C as base temperature during the crop growth period. The daily GDD and also SSH were summed up for each crop phenological stage. AET was calculated by FAO water balance method (Doorenbos and Pruit's, 1977). Following growth stages of the finger millet crop were considered.

Stage	**Description**
1.Tillering	Sowing to tillering
2.Ear emergence	Tillering to ear emergence
3.Flowering	Ear emergence to 50% flowering
4.Grain formation	50% flowering to grain formation
5.Maturity	Grain formation to harvest.

For all the years of study, the GDD, AET and SSH were computed as independent parameters for the above said stages and a multiple linear regression was developed with grain yield. Each the five crop phenological stages were included in the same equation to relate the meteorological parameters to grain yield as follows

The regression equation is

$$Y = D+(A_1*X_1+ B_1*Y_1+ C_1*Z_1+ A_2*X_2+ B_2*Y_2+ C_2*Z_2+ A_3*X_3+ B_3*Y_3+ C_3*Z_3+ A_4*X_4+ B_4*Y_4+ C_4*Z_4+ A_5*X_5+ B_5*Y_5+ C_5*Z_5)$$

Where D is a Constant.

A, B and C are GDD, SSH, and AET respectively and subscript indicates the growth stages. $X_1, Y_1, Z_1, \ldots X_5, Y_5, Z_5$ are coefficients of the variable GDD, SSH and AET at respective stages.

RESULTS AND DISCUSSION

The coefficients generated using the multiple regression equations are presented

Table 1 : Coefficients of independent variables used in multiple reqression equation

Variables	Tillering	Ear emergence	Flowering	Grain formation	Grain growth/ maturity
GDD (°C D)	-14.25 (-3.7*)	-1.39 (-0.19)	7.82 (1.19)	27.28 (1.46)	11.79 (2.11*)
SSH (hrs)	31.34 (3.1*)	-26.70 (-3.4)	-22.05 (-1.56)	-16.52 (-1.79)	-6.45 (-0.86)
AET (mm)	-27.66 (-1.62*)	51.14 (1.44)	-0.1 (0.0)	3.9 (0.41)	-26.33 (-1.22)

* 5 per cent significance Constant = 5321.7 $R^2 = 0.97$

in Table 1. Results indicate that higher GDD is favorable during flowering, grain formation and pre-harvest stages of the crop in increasing the grain yield. Particularly during the harvest stage GDD is highly significant. But GDD is not favorable during the beginning of tiller stage where it has negative and significant. The SSH coefficients show that SSH factor is favorable in the tillering stage and in this stage it has high significant value (+3.1). During the maturity and ear emergence stages SSH has negative impact on the grain yield.

Results also show that increase in AET is a favorable factor (Table 1) to achieve high grain yield during the stage of ear emergence. In this stage an increase in one unit of AET would increase the grain yield by 51.13 kg ha^{-1} and this factor has higher student's t-value. The AET non-significant at 50% flowering stage. This may be due to occurrence of rainfall during this phenological stage (during this stage in all experimental years the average rainfall was more than 30mm).This is a possible reason for contribution of AET on yield at this stage being non-significant.

Further the models predicted grain yield values of fingermillet were compared (Fig. 1) with observed yields for all years. The yield values are given in Table 2. A simple linear regression was worked out between observed and predicted grain yield. The close agreement between observed and predicted yield is supported by significant R^2 value (0.95).

Table 2 : Observed and predicted yields of fingermillet crop (1992 to1998)

Sl. No.	Observed yield (kg ha^{-1})	Predicted yield (kg ha^{-1})
1	3637	3634
2	3451	3307
3	3566	3523
4	3163	2988
5	1922	2225
6	2276	2525
7	3748	3238
8	4092	4198
9	3742	3607
10	3606	3763
11	2206	2200
12	2122	1925
13	3250	3163
14	3992	3502
15	3768	3549
16	2953	3060
17	2119	2700
18	851	600
19	5644	5438
20	5644	5688
21	4428	4122
22	4428	4084

This model was validated for grain yield observed during 1999 for two dates of sowing and two varieties. The model was able to predict the grain yield to an extent of 95 per cent that reveals its reliability.

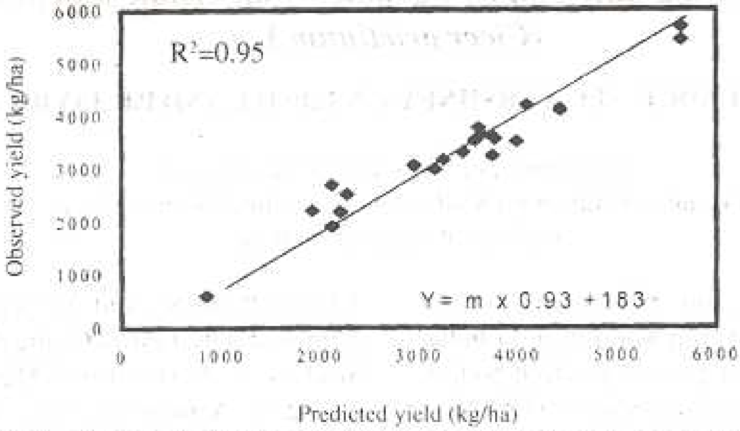

Fig.1 : Comparison between observed and predicted fingermillet yield

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