

Project No. 9

Crop growth modeling studies in *Rabi Sorghum*

Objectives:

- To study the effect of weather changes on crop growth, particularly the dry matter partitioning components
- To analyze crop growth through dynamic models like the CERES Sorghum

Results:

2000-01, 2001-02 and 2002-03

After collection of enough data for the above three years, analysis was undertaken. The Correlation analysis between crop growth parameters in different stages of crop growth and meteorological variables for the *Rabi sorghum* cultivar M35-1 was performed.

0-30 Days after sowing (Seedling stage):

Growth of the dry matter components in this stage is seen to be associated with the afternoon weather parameters – positively with thermal and negatively with hygric factors.

31-45 Days after sowing (Primordial initiation stage):

In this stage the afternoon weather variables dominate over the other parameters.

46-60 Days after sowing (Flag leaf initiation):

The variables that have good association with leaf growth in M35-1 during 46-60 DAS are, stem dry weight ($r = 0.93$) and leaf dry weight ($r = 0.89$) at 45 DAS, afternoon cloud cover ($r = -0.84$), temperature range ($r = 0.70$), morning relative humidity ($r = 0.55$) and minimum temperature ($r = -0.62$). Similarly, stem dry weight ($r = 0.75$) and leaf dry weight ($r = 0.74$) at 45 DAS, afternoon cloud cover ($r = -0.76$) and temperature range ($r = 0.71$) are the important variables having good correlation with the stem growth.

61-75 Days after sowing (Flowering):

The leaf growth has good correlation with leaf dry weight at 60 DAS ($r = 0.68$), maximum temperature ($r = 0.69$) and cumulative sunshine duration ($r = -0.81$). While the association of various weather variables with stem growth is poor, the earhead weight has good association with morning time relative humidity ($r = 0.72$).

76-90 Days after sowing (Grain filling):

During this stage, the leaf growth has significant relationship with stem and leaf dry weight at 75 DAS ($r = -0.90$ for either variable) and pan evaporation ($r = 0.71$). Conversely to the previous stage, the stem growth is well correlated with the meteorological variables, namely, cumulative sunshine ($r = 0.71$), morning vapour pressure ($r = -0.67$), and temperature range ($r = 0.52$). On the other hand the earhead growth possesses good association with earhead dry weight at 75 DAS ($r = 0.88$) and afternoon vapour pressure ($r = -0.59$).

Modeling the growth components

0-30 Days after sowing (Seedling stage):

The leaf growth in this stage is modeled by maximum temperature and pan evaporation during this period. The stem growth is modeled by afternoon relative humidity ($r^2 = 0.58$). This suggests the requirement of higher thermal energy and atmospheric demand for profuse leaf and stem growth.

31-45 Days after sowing (Primordial initiation stage):

The leaf growth in this stage has leaf dry weight at 30 DAS and afternoon vapour pressure as model parameters for M35-1 ($R^2 = 0.71$). For stem growth the model parameters are leaf dry weight at 30 DAS and afternoon vapour pressure for M35-1 ($R^2 = 0.72$). In this stage, the atmospheric hygric factor plays a crucial role in modeling the crop growth.

46-60 Days after sowing (Flag leaf initiation):

The models for leaf growth have stem dry weight at 45 DAS, morning relative humidity and temperature range as model parameters ($R^2 = 0.88$). The stem growth in this stage is modeled by stem dry weight at 45 DAS and temperature range ($R^2 = 0.64$). Thus, the weather situation during night/early morning is of importance in this period for quantification of the crop growth parameters.

61-75 Days after sowing (Flowering):

The leaf growth model in this period has leaf dry weight at 60 DAS, maximum temperature and cumulative sunshine duration (in 61-75 DAS) as model parameters ($R^2 = 0.88$). The stem growth could not be modeled in view of poor correlations. In case of earhead growth during 61-75 DAS, the morning relative humidity is the model parameters ($r^2 = 0.54$). In view of absence of dry matter component as model parameter in the models for M35-1 it becomes susceptible to weather changes in this stage.

76-90 Days after sowing (Grain filling):

The leaf growth model in this stage has evaporation as the sole parameter ($r^2 = 0.50$). The stem growth is modeled by morning vapour pressure and cumulative sunshine duration ($R^2 = 0.50$). The models for earhead growth contain earhead dry weight at 75 DAS and afternoon vapour pressure ($R^2 = 0.79$) as model parameter. Hence it is inferred that the earhead growth in this genotype is not dependent on weather variables and hence less susceptible to weather.

Table 2.2: Regression Models for growth parameters in *Rabi sorghum*

Stage	Component	Model	R
0-30	LEAF	$Y = 1.41(TX30) + 1.35(EP30) - 48.3$	0.95
	STEM	$Y = 0.124(RH230) + 8.8$	0.76
31-45	LEAF	$Y = -3.40(VP245) + 9.93(L030) + 36.5$	0.84
	STEM	$Y = -0.800(VP245) + 3.76(L030) + 7.9$	0.85
46-60	LEAF	$Y = 0.911(RH160) + 1.45(TR60) + 1.85(S045) - 83.2$	0.94
	STEM	$Y = 18.4(TR60) + 6.34(S045) - 281.6$	0.80
61-75	LEAF	$Y = 3.40(TX75) - 0.558(CBSS75) + 0.155(L060) - 30.7$	0.94
	EH	$Y = 4.83(RH175) - 336.9$	0.72
76-90	LEAF	$Y = 15.5(EP90) - 88.7$	0.71
	STEM	$Y = -3.41(VP190) + 1.10(CBSS90) - 94.4$	0.71
	EH	$Y = 2.38(VP290) + 0.929(EH75) - 31.7$	0.89

Where,

TX30	=	Maximum Temperature during 0-30 DAS
EP30	=	Evaporation rate during 0-30 DAS
RH230	=	Afternoon relative humidity during 0-30 DAS
VP245	=	Afternoon vapour pressure during 30-45 DAS
L030	=	Leaf dry weight during 0-30 DAS
RH160	=	Morning relative humidity during 45-60 DAS
TR60	=	Temperature range during 45-60 DAS
S045	=	Stem dry weight during 0-45 DAS
TX75	=	Maximum Temperature during 60-75 DAS
CBSS75	=	Cumulative sunshine during 60-75 DAS
L060	=	Leaf dry weight during 0-60 DAS
RH175	=	Morning relative humidity during 60-75 DAS
EP90	=	Evaporation rate during 75-90 DAS
VP190	=	Morning vapour pressure during 75-90 DAS
CBSS90	=	Cumulative sunshine during 75-90 DAS
VP290	=	Afternoon vapour pressure during 75-90 DAS
EH75	=	Evaporation rate during 0-75 DAS

2003-04

The meager annual rainfall of 276.1mm was insufficient for development of crop stand and vitiated the experiment. The experiment is continued in the coming years. Testing of Dynamic simulation models will be undertaken in the coming years.