Impact of Climate and Weather Variations on the Yield and Stability of Sweet Corn Under Semi-Arid Conditions

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ABSTRACT. A field experiment was conducted on clay loam soil at Maize Research centre, Acharya NG Ranga Agricultural University, ARI, Rajendranagar, Hyderabad, Andhra Pradesh(A.P.) , India for 3 years during 2009-10, 2010-11 and 2011-12 with an objective to evaluate the impact of climate and weather variations on the yield and stability performance of sweet corn hybrid (Sugar- 75) under semi - arid conditions. The treatments tested were 12 dates of sowing (15th of each calendar month) in all of the three years, in a randomized block design replicated thrice. Eberhart and Russel's stability model indicated that the sweet corn hybrid sown on 15th June during *kharif*, 15th November during *rabi* and 15th May in *summer* season was more dependable.The high mean yield, regression coefficient not significant from unity, and near zero value for deviation from regression, were main reasons for high dependability of those dates of sowing. Analysis of weather data revealed that when Sugar-75 was exposed to seasonal weather and climate variations under field conditions, its yield was predominantly influenced by air temperature and its derived parameters viz., GDD and HTU, irrespective of seasons and dates of sowing. The crop sown on 15th November, recorded significantly higher yield of 21.8 t/ha during post monsoon season, which was 33% higher than that of 15th June sown crop i.e., during SW monsoon season and 32 % more than the crop sown on May 15th during *Summer* season. The Radiation Use Efficiency (RUE) values were 2.90, 2.10 and 1.90 MJ/ m^2 for the crops sown on 15th November, 15th June and 15th May respectively, indicating that the highest production in post monsoon season was due to high RUE. The stable performance of the hybrid as determined by stability analysis was very much linked to weather parameters which were found to be on expected lines in the present study.

Key words: Sweet corn hybrid, yield, climate and weather variations, stability analysis, GDD, HTU and RUE.

Introduction

The last decade of the 20th century witnessed extensive economic reforms in India, which in turn saw growing stocks of surplus of wheat and rice. This, however came at an associated cost of degradation of both soil and water resources. At the global level, prices of these two leading cereals declined sharply, inducing the farming community to partly diversify agriculture to sustain and augment farm income and improve the quality of soil and water resources. Maize is considered a promising option and high yielding hybrids that have inherent stability in performance over different agronomic and agro climatic conditions are of great significance in countries like India towards sustainable production and productivity. Apart from normal maize, cultivation of sweet corn hybrids can be more profitable in the present context owing to the production of green fodder along with the fresh delicious green cobs for use as snack food by urbanites. Sincemaize can be grown round the year in south and central India, with minimum irrigation facilities, suitable/optimum date of sowing in each of the three seasons to realize higher yield particularly for sweet corn hybrids needs to be investigated. It is in this context that the present study programmed to quantify the effect of planting dates on sweet corn hybrid, assumes a lot of significance.

Material and Methods

The material for the present investigation comprised of one sweet corn hybrid (Sugar-75) tested in 12 different dates of sowings i.e., four dates of sowing in each season in randomized block design for three years from 2009-10 to 2011-12 at Maize Research Centre, ARI, Rajendranagar, Hyderabad, A.P., India. The plot size for each treatment was six rows of four meter length with a row distance of 75x20 cm. Normal cultural practices as recommended for sweet corn were followed. The statistical analysis was done as suggested by Eberhart and Russell (1966) for stability parameters. Agro meteorological indices like Growing Degree Days (GDD),heliothermal Units (HTU) and radiation use efficiency (RUE) were computed by adopting the procedure laid out by Rajput (1980) and Murthy (2012).

Growing Degree Days (GDD): A degree day is the difference between the mean temperature of the day and base temperature. Growing degree days (GDD) are used to match crop requirements for heat to the amount of heat available. The base temperature for calculating growing degree days is the minimum threshold temperature at which plant growth starts (GA, 2003).

$$\text{Growing degree days } (^0C \text{ days}) = \Sigma \frac{T_{max}+T_{min}}{2} - T_{base}$$

Where,

T_{max} = Maximum temperature (^{0}C),

T_{min} = Minimum temperature (^{0}C) and

T_b = Base temperature=10^{0}C for *kharif* and *summer* and 5^{0}C for *rabi* (Murthy, 2012).

Heliothermal Units (HTU): The heliothermal units for a given day represent the product of GDD and the actual hours of bright sunshine for that day. The sum of the HTU for the duration of each phenophase was determined by using the following formula.

Accumulated HTU (^{0}C day hr)=GDD x Duration of sunshine hour

Radiation Use Efficiency (RUE):

$$RUE = \frac{\text{Amount of dry matter produced } (gm^{-2})}{\text{Amount of cumulative radiation absorbed } (MJm^{-2})}$$

Results and Discussion

The performance of sweet corn hybrid differed significantly over different sowing dates (Table 1). The response curves of different sowing dates over three years in *kharif*, *rabi* and *summer* seasons were presented in figure 1. During *kharif* season the maximum response was obtained when the crop was sown on June-15th (14.7 t/ha). Similar pattern was observed when the hybrid was tested during *summer* season where in May 15th sowing gave highest yield of 15.0 t/ha. On the contrary, during the *rabi* season although the different dates of sowing differed significantly, both linear and non linear components of DSxE interaction were non significant. This indicated that the performance of the hybrid was almost similar with respect to stability behavior and the prediction of performance of the hybrid over different dates of sowings was easy, highly dependable based on linear models.

Table 1. Analysis of variance for dates of sowing for corn-cob yield.

Source	df	Mean squares		
		Kharif	Rabi	Summer
Dates of sowing (DS)	3	17.532**	16.094*	22.112**
Environment	2	18.815**	0.0833	11.643**
DS x Environment	6	2.381	1.436	2.698**
Environment (lin)	1	37.631**	0.166	23.286**
DS x Env (lin)	3	3.429	1.103	5.273**
Pooled deviation	4	1.000**	1.327**	0.093
Pooled error	18	0.138	0.077	0.086

*, ** Significant at 1 and 5% level respectively

According to Eberhart and Russel stability analysis, during *kharif* season the performance of the hybrid in 15thJune sowing was considered stable under favorable environment because of high mean yield, regression coefficient (bi) more than unity and deviation from regression (S2 di) nearer to zero (Table 2).

All of the four different dates of sowing influenced the yield performances of the sweet corn hybrid significantly during rabi season. However, environment effect was not significant indicating similar seasonal conditions prevailing during *rabi*. Mean squares due to

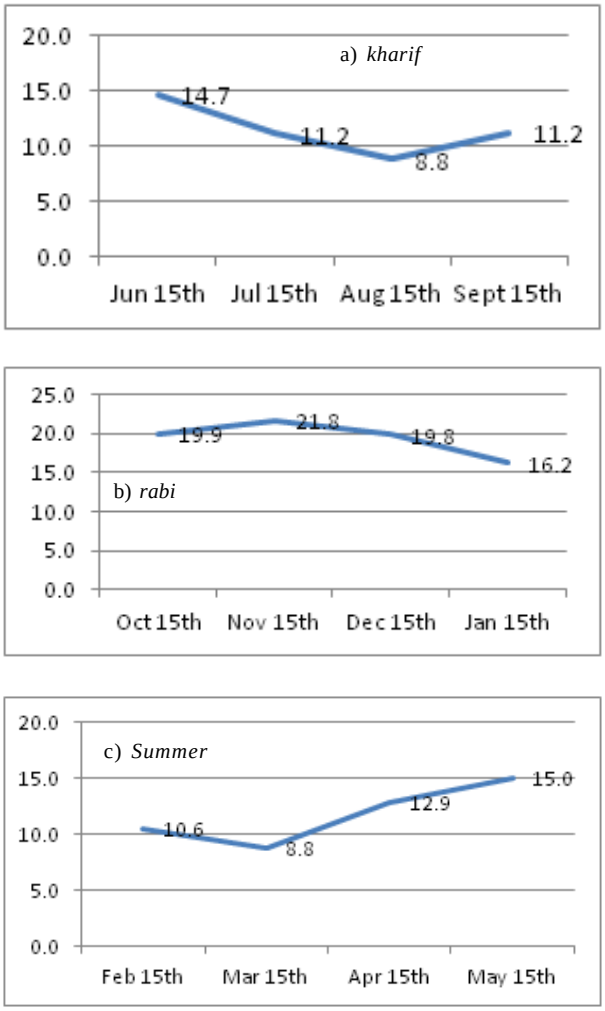

Figure 1. Response curves of different sowing dates in three different seasons over three years.

Table 2. Stability parameters for yield in sweet corn hybrid.

Date of sowing	$\bar{X}$ Cob-yield (t/ha)	S^2Di	bi
Kharif			
June	14.7	0.026	1.489
July	11.2	1.697	0.704
Aug	8.8	1.782	1.515
Sep	11.2	0.003	0.292
Rabi			
Oct	19.9	2.320	-4.000
Nov	21.8	-0.095	-2.601
Dec	19.8	2.780	6.800
Jan	16.2	-0.095	3.800
Summer			
Feb	10.6	-0.015	2.417
Mar	8.8	0.108	0.367
April	12.9	-0.002	0.586
May	15.0	-0.074	0.630

DSxE interaction were non significant indicating consistent performance of the hybrid over three different years. Therefore, the performance of the hybrid was predictable across the environments.

The mean squares of dates of sowings and environment for green cob yield during *summer season* were highly significant indicating that all the four dates of sowings will have influence on the performance of the hybrid individually and similarly environments were different from one another.Variation due to DSxE was also significant suggesting differential behavior of the hybrid under different environments. Thus differential performance of the sweet corn hybrid when grown over three environments seasonal variation in different dates of sowings is unpredictable.

The estimates of stability parameters in respect of four different dates of sowings suggest that the performance of sweet corn hybrid was stable when sown during the month of May on 15thas evidenced by high mean (15.0 t/ ha) with *bi* value nearly to unity and deviation equal to zero.

The trends in absorption of photosynthetically active radiation and its use efficiency were consistent in response to monthly dates of sowings. The seasonal variations indicated that the crop had higher RUE in *rabi* season than in *kharif*and it was least in *summer.*The mean Radiation Use Efficiency values were 2.90, 2.10 and 1.90MJ/ m^2 for the crops sown on 15thNovember, 15th June and 15th May, respectively. The highest green cob yield is recorded in post monsoon sown crop, i.e. 15thNovember in all the years.

Table 3. Mean green cob yield, GDD, HTU and RUE as influenced by dates of sowing.

Treatment	Mean Green Cob yield over 3 years (t/ha)	GDD (^{0}C days)	HTU (^{0}C days hr)	RUE (g/Mj)
15-Jun	14.7	1456	6393	2.10
15-Jul	11.2	1402	6422	1.70
15-Aug	8.8	1343	7172	1.60
15-Sep	11.2	1247	8046	1.70
15-Oct	19.9	1588	11452	2.75
15-Nov	21.8	1493	12023	2.90
15-Dec	19.8	1595	13600	2.74
15-Jan	16.2	1847	15801	2.21
15-Feb	10.6	1593	13408	1.69
15-Mar	8.8	1790	14741	1.60
15-Apr	12.9	1785	12638	1.81
15-May	15.0	1619	8701	1.90

It was further observed that when Sugar-75 was exposed to seasonal weather and climate variations under field conditions, its yield was predominantly influenced by air temperature and its derived parameters viz., GDD and HTU. These dependable parameters influenced the green cob yield irrespective of seasons and dates of sowing (Table 3)

Therefore, the sowing time 15th November in *rabi*, 15th June in *kharif* and 15th May in *Summer*are ideal schedule to realize maximum green cob yield. The importance of allowing Sugar-75 to higher RUE by the agronomic and agro meteorological management strategy of dates of sowing had also been reported by Murthy (2012). Similar trends were observed in case of GDD and HTU.

Based on the present findings the highest yield of 21.8 t/ha is possible when the GDD,HTU and RUE values are respectively 1493, 12023 and 2.90, on 15thNovember. For *summer* season the best yield of 15t/ha is possible with 1619, 8701 and 1.90 of those parameters. On the same analogy the best combination for realizing 14.7 t/ha of green cob yield in Kharif needs 1456 GDD, 6393HTU, and 2.10 RUE. Agrometeorological and agronomic management options like adjusting dates of sowing and coinciding the reproductive phases of the crop withlight sensitive days to the extent possible may be adopted keeping these critical GDD, HTU and RUE values.

Thus the stable performance of the hybrid as determined by stability analysis is very much linked to weather parameters which were found to be on expected lines in the present study.

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