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Short Comminucation

Evaluating contribution of weather to growth and yield of *kharif* maize (*Zea mays* L.) under irrigated conditions

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The agricultural productivity of geographic area is dependent on many factors including inherent soil and terrain characteristics and climatic constraints (Liu and Samal, 2002). In Andhra Pradesh, maize area increased from 4.4 lakh ha (2000) to 8.5 lakh ha (2009) with higher productivity of 4882 kg ha^{-1} (CMIE, 2009). Introduction of high yielding single cross maize hybrids coupled with high input management and its spread to non traditional areas of rice-pulse system have resulted in more production. However timely sowing of the crop during *kharif* season is utmost important for realizing higher yields.

There are several evidences showing that, delay in sowing of maize beyond July results in yield reduction. In the event of late onset of monsoon rains and erratic rainfall farmers are forced to take-up sowing late *i.e.*, beyond 15 July; and the sowing may even be extended to the end of August month. Shift in sowing dates directly influence both thermo and photoperiod, and consequently a great bearing on the phasic development and partitioning of drymatter. Quantification of these effects may help in the choice of sowing time and match phenology of crop in specific environment to achieve higher grain yield. Hence, there is a need to study the influence of different weather parameters on the performance of maize grown different environments as affected by change in sowing date.

A field experiment was conducted during *kharif* seasons of 2009 and 2010 at Agricultural Research Institute farm, ANGRAU, Rajendranagar, Hyderabad having 17^0 19' N latitude, 78^0 23' E longitude and 542.3 m above mean sea level. The soil of the experimental site was sandy loam in texture, neutral in reaction, low in available nitrogen, phosphorus and high in available potassium. The crop was sown in four dates of sowing : 7 July, 21 July, 06 August and 22 August in 2009 and 18 June, 02 July, 17 July and 02 August in 2010. The cultivar used for the study was Dekalb Super 900M. Crop was fertilized with uniform dose of 200 kg N, 60 kg P_2O_5, 40 K_2O and 50 kg $ZnSO_4$ kg ha^{-1}. One third of the total N and full P, K and $ZnSO_4$ were applied at the time of sowing as basal. Remaining N was applied in two equal splits 30 days after sowing (DAS) and at tasseling stage. Other cultural operations and plant protection measures were followed as per the recommendations contained in package of practices.

The weather data during experimental period were recorded from the meteorological observatory located at Agricultural Research Institute, Rajendranagar, Hyderabad. Maize crop growth period was divided into six phenophases viz.

P_1 = Emergence to six leaf stage;

P_2 = Six leaf to tasseling stage;

P_3 = Tasseling to silking stage;

P_4 = Emergence to silking;

P_5 = Silking to physiological maturity;

P_6 = Sowing to physiological maturity (Hanway, 1962).

The correlation coefficients were also worked out between weather parameters during different phenophases with drymatter and grain yield of maize. Regression analysis (Draper and Smith, 1996) was carried out considering those weather parameters, which had significant influence on crop growth, yield and yield attributes were entered in this analysis to derive prediction models separately. However, the best suited regression equations are elaborated in this paper.

Weather factors that prevailed during various phenophases of maize, sown under staggered dates influenced the final yield of the crop through their influence on different growth and yield attributes. The critical agro

Table 1 : Correlation coefficients between weather parameters and drymatter and yield of maize during different phenophases

Growth stage	Maximum temperature (°C)	Minimum temperature (°C)	Morning relative humidity(%)	Afternoon relative humidity(%)	Mean temperature (°C)	Radiation (MJ m^{-2})
Drymatter at maturity						
P_2	0.57	0.70*	-0.79*	-0.71*	0.55	-0.19
P_3	-0.20	0.73*	-0.31	0.34	0.15	-0.59
P_4	-0.14	0.67	0.68	0.67	0.64	-0.39
P_5	0.75*	0.67	0.25	0.13	0.84**	-0.29
P_6	0.12	0.85**	-0.57	-0.02	0.56	-0.48
P_7	0.49	0.74*	-0.29	0.07	0.88**	-0.44
Grain yield						
P_2	0.55	0.68	-0.80*	-0.69	0.52	-0.19
P_3	-0.15	0.71*	-0.31	0.29	0.18	-0.52
P_4	-0.15	0.64	0.70*	0.66	0.60	-0.43
P_5	0.76*	0.64	0.21	0.12	0.82*	-0.27
P_6	0.15	0.82*	-0.57	-0.05	0.56	-0.45
P_7	0.50	0.71*	-0.31	0.05	0.86**	-0.40

* Significant at 5% level; ** Significant at 1% level

Note: P_2=Emergence to six leaf stage; P_3=Six leaf to tasseling stage; P_4=Tasseling to silking stage; P_5=Silking to physiological maturity; P_6=Emergence to silking; P_7= Emergence to physiological maturity;

meteorological variables associated with agricultural production are precipitation, air temperature and solar radiation (Hoogenboom, 2000). By relating and comparing the agro-climatological requirements of the crop with the existing agro-climatic conditions in an area, one can find the extent to which the requirements are satisfied during the different phases of the crop growth and development (Todorov, 1981).

Individual correlation of weather parameters which significantly influenced the drymatter of crop sown at different dates of sowing (Table 1) were worked out. Minimum temperature and mean temperature showed +ve correlation with drymatter production at physiological maturity. However, maturity stage drymatter production (DMP) showed significant +ve correlation (0.75*) with maximum temperature and mean temperature (0.84**) at P_5 stage (silking to physiological maturity), but minimum temperature had significant +ve correlation (0.70*) at P_2 (emergence to six leaf), P_3 (0.73*) (six leaf to tasseling) and P_6 (0.85**) (emergence to silking) stages, In addition to minimum temperature, vapour pressure deficit (0.74*) also exerted +ve correlation at P_2 stage DMP . In variance to the above results morning and afternoon relative humidity at P_2 (emergence to six leaf) stage showed significant negative correlation with maturity phase DMP. This indicates that, increase in morning and afternoon relative humidity reduced the DMP and there by reduction in grain yield was observed.

Minimum temperature (0.71*) and mean temperature (0.86**) played important role during crop growth period to obtain higher yields, as this was evidenced from significant positive correlation with grain yield at P_7 stage (emergence to physiological maturity)

Final grain yield showed significant +ve correlation (0.76*) with maximum temperature and mean temperature (0.82*) at P_5 stage, where as minimum temperature showed +ve correlation with grain yield at P_3 (0.71*) and P_6 stages. However, morning relative humidity that prevailed at P_4 stage (tasseling to silking stage) showed +ve (0.70*) correlation with final grain yield. These results are in conformity with the results of Huda *et al.*, 1976 and Baktash, 1985.

Accumulated mean minimum and mean temperatures that prevailed from emergence to silking and from silking to physiological maturity stage, accounted for 73% and 77% variation in drymatter production at physiological maturity, respectively.

$Y = -940.48^{**} + 45.32^{**} P_7 Tmean$ 0.77

$Y = -1072.7^{**} + 57.7^{**} P_6 Tmin$ 0.73

Where,

Y = Dry matter kg ha^{-1}

P_6 Tmin = Mean minimum temperature (°C) from emergence to silking stage

P_5Tmean= Mean temperature (°C) from silking to physiological maturity

P_7Tmean= Mean temperature (°C) from emergence to physiological maturity

Regression equation involving grain yield subjected to 74% variation with mean temperature, which prevailed from emergence to physiological maturity stage. In a similar way minimum temperature during emergence to silking stage accounted for 68% variation in final grain yield.

$Y = -15753.0^{*} + 908.7^{**} P_7 Tmean$ 0.74

$Y = -17978^{*} + 1138.3^{**} P_6 Tmin$ 0.68

Where,

Y = Grain yield kg ha^{-1}

P_2 RH1 = Mean morning relative humidity (%) during emergence to six leaf stage

P_7Tmean= Mean temperature (°C) from emergence to physiological maturity

P_6 Tmin = Mean minimum temperature (°C) from emergence to silking stage

Perusal of the relationship between weather parameters and growth and yield parameters revealed that, a mean morning relative humidity range of 74.6 to 79.8% was found to be optimum from emergence to six leaf stage for higher DMP at six leaf and tasseling stages and more number of grains cob^{-1}. Similarly, mean minimum temperature range of 22.8 to 23.2°C from emergence to silking (P_6) was found to be optimum for higher DMP at physiological maturity and grain yield at maturity in *kharif* maize. Higher DMP at physiological maturity and grain yield of maize was obtained with mean temperature of 26.3 to 26.9°C from emergence to physiological maturity. These results are corroborating with the experimental results of results of CIMMYT (CIMMYT, 1975).

It is thus concluded that higher grain yield of maize is obtained during the *Kharif* season if the minimum temperature ranged from 18.9 – 22.5°C. At the same time high range of both morning and afternoon relative humidity during early stage was unfavourable for maize crop which affected the crop dry matter production and the weather based regression models showed utility for predicting the above ground biomass, yield and yield components of *Kharif* maize in the South Telangana agro climatic zone of Andhra Pradesh.

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