Journal of Agrometeorology 13 (1): 43-45 (June 2011)

Heat unit utilization of kharif maize in transitional zone of Karnataka

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ABSTRACT

A field experiment was carried out during *kharif* seasons of 2005 and 2006 to study the effect of heat and thermal unit use of maize cultivars in red sandy loam soil at Zonal Agricultural Research Station, Shimoga (Karnataka, India). The experiment consisted of three dates of sowing *viz*., first fortnight of June, second fortnight of June and first fortnight of July with six cultivars *viz*., two double cross hybrids (All-rounder and 30 R-77), two single cross hybrids (NAH-2049 and 30 V-92) and two composites (NAC-6004 and NAC-6002) was laid out in split-plot design replicated thrice. Higher heat use efficiency was recorded with the crop sown in first fortnight of June and decreased with each delay in sowing. Grain yield of maize was found inversely related to the helio-thermal units. Thus, early sowings escape adverse situation during its life cycle in maize.

Key words: GDD, heat u*se* efficiency, helio-thermal units, maize

Three climatic parameters *viz.*, temperature, rainfall and light are most important for optimum crop growth and development there by exploits the potentiality of a crop. Among these, temperature plays a vital role in almost all biological processes of crop plants. Influence of different time of sowing as well as temperature on growth and yield of wheat has been studied under field conditions through the accumulated heat units by Rajput *et al*. (1987). However, the growing degree day (GDD) concept may mislead as the minimum and maximum temperatures are being considered for calculating GDD which are the events occurring at a particular point of time in a day. As the planting is delayed beyond optimum date/ideal time, the maize yields go down. Early sown maize plants are able to face and tolerate the adverse weather and environment. In rainfed situation, the sowing of maize is generally done with the onset of monsoon rains. Most suitable temperature for germination is 21 ^{0}C and for growth 32 ^{0}C (Jain, 1973). Extremely high temperature, moisture stress and low humidity during flowering damage the flowering and the foliage, desiccation of pollen and interfere with the pollination resulting in poor grain formation. Thus, rate of development of maize from planting to anthesis is a function of temperature rather than photosynthesis (Brower, *et al*., 1970). So a field experiment was conducted to study the effect of Growing Degree Days (GDD) on dry matter production, heat use efficiency and yield response of maize genotypes to Helio-Thermal Units (HTU).

MATERIAL AND METHODS

A field experiment was carried out during *kharif* seasons of 2005 and 2006 on red sandy loam soils (*Alfisols)* of Zonal Agricultural Research Station, Shimoga, Karnataka state (India). Eighteen treatment combinations, three dates of sowing (June first fortnight, June second fortnight of July first fortnight) and six cultivars of maize (two double cross hybrids: All-rounder and 30 R-77, two single cross hybrids : 30 V-92 and NAH-2049 and two composites : NAC-6004 and NAC-6002) were tried in a split-plot design with three replications.

A common cultivation practices were followed for all genotypes as per the recommended package of practices for the Agro-climatic Zone. Geographically, the experimental site is situated at 14^{o}.0' to 14^{o}.1' N latitude and 75^{o}.40' to 75^{o}.42' E longitude at an altitude of 650 meters above mean sea level. The normal rainfall of experimental site was 800 mm (54 rainy days) with maximum temperature being recorded in the month of April (35.8^{o}C) and minimum temperature (14.8^{o}C) during January. Sowing of maize was done in rows 60 cm apart with intra row spacing of 30 cm. A common dose of 50 kg N, 50 kg P_2O_5 and 25 kg of K_2O was applied in the form of urea, DAP and muriate of potash as basal at sowing. Another 50 kg N was given as top dress in the form of urea at 30 DAS. Recommended dose of farm yard manure @ 7.5 t ha^{-1} was applied 15 days earlier to sowing to all treatment plots.

Growing degree days at different phenological stages were calculated by summation of daily mean temperature above base temperature for a corresponding period from sowing, as suggested by Monteith (1984) using base temperature of 10^{0} C and heat use efficiency (HUE) was

Part of Ph.D (Agronomy) Thesis submitted to the University of Agricultural sciences, Bangalore by first author

Table 1: Dry matter accumulation and heat use efficiency (g/GDD) as influenced by date of sowing in maize

Crop Growth Stage	1st fortnight of June			2nd fortnight of June			1st fortnight of July		
	GDD	Total dry matter (g plant^{-1})	HUE	GDD	Total dry matter (g plant^{-1})	HUE	GDD	Total dry matter (g plant^{-1})	HUE
Knee ht. stage (30 DAS)	433.1	20.2	0.047	421.1	16.1	0.038	427.2	9.99	0.023
Silking stage (60 DAS)	861.4	138.1	0.160	860.0	117.8	0.137	879.2	95.5	0.109
Grain development stage (90 DAS)	1313.2	215.3	0.164	1306.6	168.2	0.129	1331.8	129.2	0.097
At physiological maturity	1766.8	251.8	0.143	1761.1	194.6	0.110	1768.8	146.3	0.083

Table 2: Yield response of maize to helio thermal units (HTU) and helio-thermal use efficiency (HTUE) across sowing and genotype groups

Duration (days)	Date of sowing	Grain yield (kg ha^{-1})	HTU	HTUE (kg / HTU)
Long duration (130-140 days)	D$_1$: First fortnight of June	7313	7142	1.02
	D$_2$: Second fortnight of June	5507	7231	0.76
	D$_3$: First fortnight of July	4023	8371	0.48
Relatively lesser duration (120-130 days)	D$_1$: First fortnight of June	6530	6449	1.01
	D$_2$: Second fortnight of June	5154	6918	0.75
	D$_3$: First fortnight of July	3508	7650	0.46
Short duration (90-100 days)	D$_1$: First fortnight of June	5000	4588	1.09
	D$_2$: Second fortnight of June	4562	4724	0.96
	D$_3$: First fortnight of July	4528	5910	0.77

calculated as:

$$\text{HUE} = \frac{\text{Total dry matter (g m}^{-2}\text{)}}{\text{GDD}}$$

The helio thermal unit (HTU) was calculated using the formula given by Rajput (1980), and helio-thermal use efficiency (HTUE) was calculated by using the formula:

$$\text{HTUE (kg/HTU)} = \frac{\text{Yield (kg ha}^{-1}\text{)}}{\text{HTU}}$$

To relate the yield to helio-thermal units, the selected maize cultivars were grouped into three *viz*., long duration group (All-rounder, NAH-2049 and NAC-6004) 130-140 days, medium duration group *i.e.*, 120-130 days (30 R-77 and 30 V-92) and short duration composite NAC-6002 (90-100 days).

RESULTS AND DISCUSSION

Growing degree day

The maximum heat units of 1766.8 degree days from sowing to harvest were recorded by sowing in first fortnight of July sowing which is almost equal to June first fortnight sowing (1766.8 degree days). However, at seedling stage (up to 30 DAS) highest heat units were recorded in June first fortnight sowing (Table 1).

Heat use efficiency

Total dry matter per plant was found to be significant at all crop growth stages. Significantly higher dry matter per plant was noticed recorded with June first fortnight sown crop at all the stages. The progressive decrease in total dry matter per plant was observed with each delay in sowing (Table 1). Reason could be exploitation of climatic and soil moisture at important growth stages by the crop sown early and higher leaf area index which might have provided more photosynthetic area and contributed more dry matter. Also attributed to higher growing degree days available for and heat use efficiency by early sown crop. Higher dry matter production per unit of heat was higher at all growth stages with June first fortnight than later sown crop (Table 1).

Higher heat use efficiency of 0.047, 0.16, 0.164 and 0.143 g/GDD was recorded with the crop sown in first fortnight of June at 30, 60, 90 DAS and harvest, respectively but decreased correspondingly with each delay in sowing (Table 1).

Helio-thermal units (HTU) and Helio-thermal use efficiency (HTUE)

Helio thermal units available for the crop from it's sowing to physiological maturity were higher for the crop sown during 1st fortnight of July. This is true for all genotype groups. This is because of the growth of the later sown crops extended up to November second week where in monsoon ceases and grin filling stages of delayed sown crops subjected to bright sunny days coupled with long dry spells. However, the short duration composite was found relatively stable with respect to yield for dates of sowing as the reduction in yield due to delayed sowing was lesser than in remaining genotypes Further, availability of helio thermal units for short duration variety did not vary much across dates of sowing due to its low maturity period (Table 2). Greater reduction in yield of long season corn varieties under delayed sowing situations was attributed to decrease in season length might have an effect by of reduction in their potential yield (Johannes M. Makadho, 1996).

Relatively higher HTUE and lower HTU were noticed in June first fortnight sowing which yielded higher biomass at all growth stages. Maximum HTUE was obtained with sowing in June first fortnight (early sowing). This is true with respect to all genotype groups. However, short duration genotype NAC-6002 has exhibited higher HTUE than long duration groups. This could be attributed to exposure of long duration genotypes to bright sunny days coupled with long dry spells at their later growth period (grain filling stage). While, inverse relationship between HTU and grain yield of maize was noticed with all the genotype groups (Table 2). Negative relationship of HTU with yield also reported by Rajaput *et al.* (1987) and Thavaprakash *et al.* (2007) in baby corn. Similarly, negative impact of increase in temperature especially when coupled with decrease in precipitation in spite of bright sunshine hours was reported by Rosenzweig *et al*. (1994).

In all, early sown maize has taken the advantage of optimum temperature and sunlight during the early stages of plant development and there by avoided adverse situations during its life cycle. Results obtained clearly indicate the negative correlation between helio-thermal units (HTU) and yields of maize. Surprisingly, HTU under delayed sowing was higher. This is because delayed sown crops exposed more to the cloud free situation coupled with dry weather during later part of their growth period where monsoon season ceases. Thus, the role of HTU should be understood in various crops for all Agro-climatic Zones of the country

REFERENCES

Brouwer, R., Jenneskens, P.J. and Borggreve, (1970). Growth responses of shoots and roots to interruptions of irrigation supply. Jaarb. IBS: 29-36.

Jain, (1973). New Agronomy boosts in maize yield. *Indian Fmg.,* 23 (1): 17-20.

Johannes, M. Makadho, (1996). Potential effects of climate change on corn production in Zimbabwe. *Climate Research.*, 6: 147-151.

Monteith, J.C., (1984). Consistency and Convenience in the choice of units for agricultural sciences, *Expl. Agric*., 20: 115-117.

Rajput R. P., Deshmukh, M.R. And Paradkar, V.K., (1987). Accumulated heat units and phenology relationship in wheat as influenced by planting dates under late sown conditions. *J. Agron. Crop Sci*., 159:345-348.

Rosenzweig C. Parry ML, (1994). Potential impart of climate

Received: July 2010; Accepted: April 2011