THERMAL REQUIRMENT OF MAIZE INFLUENCED BY PLANTING DATES AND INTRA- ROW SPACING

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ABSTRACT-A field experiment with Maize (Zea mays L.) c.v. Ganga Safed – 2 was conducted at Crop Research Centre of the G. B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand during Kharif season of 2011 with four planting dates viz P1 (16 May), P2 (31 May), P3 (15 June) and P4 (30 June), three nitrogen levels Viz. N1 (80 kg N/ha), N2 (120 kg N/ha) and two intra-row spacing viz. S1 (10 cm) and S2 920 cm), respectively. Various thermal indices including Growing degree days (GDD), Photothermal units (PTU), Heliothermal unit (HTU), Heat use efficiency (HUE), and Photothermal index (PTI) for Maize were calculated using standard methods for above treatments. The results showed that minimum significant GDD accumulation at various growth stages were observed at P3 sowing date and it was 67.7, 874.2, 982.46 and 1566.27 at emergence, 75 % tasseling, 75 % silking and at maturity, respectively. Also, the minimum GDD was highly significant (1067.21) at 75 % silking at S2 spacing and was 1628.77 at S1 spacing for 75 % tasseling.. The HTU was observed to be significantly minimum of 396.9 for P4 at emergence. However, for 75 % tasseling, 75 % silking and at maturity, the minimum values of HTU were observed to be 4692.72, 5403.67 and 8967.66, respectively, at P3 planting. Maximum PTU accumulation of 20494.7 was observed at S1 level at maturity. The effect of planting date, nitrogen level and spacing on PTI. A maximum significant HUE of 49.76 g oC-1 day-1 was observed at P3 planting date. However, maximum significant HUE of 42.65 g oC-1 day-1 was observed at S1 level, while minimum HUE (39.81 g oC-1 day-1)was observed at S2 spacing.

The correlation – regression analysis showed that PTU provided better estimates for emergence (r=0.932) while GDD estimated 75 % tasseling (r=0.999) and maturity (r=0.94) more accurately than HTU and PTU. The thermal indices were found to negatively correlated with yield (r=0.253 for GDD; r=-0.085 for HTU and r=-0.251 for PTU, respectively for the Kharif season. However, a positive correlation (r=0.20, r=002 r=0.20 for GDD, HTU and PTU, respectively) with yield was observed for 15 June sowing Maize.

It can be concluded from this study that minimum of GDD, HTU and HUE for growth, development and yield were found to be optimum for 15 June planting (P3) with 120 kg N / ha and 20 cm row spacing. However, the photothermal index was significantly affected by planting date, nitrogen level and intra row-spacing.

INTRODUCTION

Temperature plays a key role in the physiological and morphological development of the crops. Temperature primarily affects growth duration with lower temperature increasing the length of time that the crop could intercept radiation. The effect of temperature on crop is accounted through the concept of heat unit which is based on the fact that crop needs a certain amount of temperature requirement for the completion of each stage of its ontogency. The seasonal variation of crops and varieties can be effectively answered through its heat unit requirement. Varughese and Iruthayaraj (1995) showed that heat unit requirement for rabi crops was less than for kharif crops for all physiological phases. In the present investigation, the study was made for kharif maize cv Ganga –Safed-2 under Tarai conditions of Uttarakhand at Pantnagar using a set of data observed through experiment conducted during kharif 2011 in order to know the thermal requirement of maize as influenced by planting date and spacing under various nitrogen levels.

MATERIALS AND METHODS

The soils of Tarai & Bhabar agroclimatic zone i.e. of study area alluvium derived young soils. The alluvium is dominantly loamy and silty. Soils are characterised by the presence of dark colored organic matter rich (1-4 per cent) in the upper horizon and fall under Mollisols. Tarai soils are associated with shallow to deep ground water table with good quality of water (EC < 0.4 dSm-1). These soils are fine to medium texture. Soil of Tarai-Bhabar transition are dark colored, some are deep but mostly shallow and have lithological discontinuity at 25-30 cm depth. The climate of the region is Humid Sub -Tropical with an average annual rainfall of 1433.4 mm. A field experiment with Maize (Zea mays L.) c.v. Ganga Safed – 2 was conducted at Crop Research Centre of the G. B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand during Kharif season of 2002 with four planting dates viz P1 (16 May), P2 (31 May), P3 (15 June) and P4 (30 June), three nitrogen levels Viz. N1 (80 kg N/ha), N2 (120 kg

N/ha & N3 (160 kg N/ha) and two intra-row spacing viz. S1 (10 cm) and S2 20 cm), respectively. Various thermal indices including Growing degree days (GDD), Photothermal units (PTU), Heliothermal unit (HTU), Heat use efficiency (HUE), and Photothermal index (PTI) for Maize were calculated using standard methods for above treatments.

Estimation of various thermal Indices:

1. **Growing degree days (GDD) (Aspiazu and Shaw 1972)**

$$GDD = \left[\frac{T_{\max} + T_{\min}}{2}\right] - T_b$$

2. **Photothermal Unit (PTU) (Major et. al. 1975)**

$$PTU = GDD \times MDL$$

3. **Heliothermal Unit (HTU) (Sastry and Chakravorthy, 1982)**

$$HTU = GDD \times BSS$$

4. **Heat use efficiency (HUE) (Rajput, 1998)**

$$HUE = \left[\frac{Yield}{GDD}\right]$$

5. Photo-thermal Index (PTI)

PTI = Ratio of Degree days and number of days between two physiological stages

RESULTS & DISCUSSION

The results showed that minimum significant GDD accumulation at various growth stages were observed at P3 sowing date and it was 67.7, 874.2, 982.46 and 1566.27 at emergence, 75 % tasseling, 75 % silking and at maturity, respectively. Also, the minimum GDD was highly significant (1067.21) at 75 % silking at S2 spacing and was 1628.77 at S1 spacing for 75 % tasseling.. The HTU was observed to be significantly minimum of 396.9 for P4 at emergence. However, for 75 % tasseling, 75 % silking and at maturity, the minimum values of HTU were observed to be 4692.72, 5403.67 and 8967.66, respectively, at P3 planting. Maximum PTU accumulation of 20494.7 was observed at S1 level at maturity. The effect of planting date, nitrogen level and spacing on PTI. A maximum significant HUE of 49.76 g oC-1 day-1 was observed at P3 planting date. However, maximum significant HUE of 42.65 g oC-1 day-1 was observed at S1 level, while minimum HUE (39.81 g oC-1 day-1) was observed at S2 spacing. These results are depicted in Figs.1 to 4 and are given in Table 1.

The correlation – regression analysis showed that PTU provided better estimates for emergence (r=0.932) while GDD estimated 75 % tasseling (r=0.999) and maturity (r=0.94) more accurately than HTU and PTU. The thermal indices were found to negatively correlated with maize yield (r=0.253 for GDD ; r=-0.085 for HTU and r =-0.251 for PTU, respectively) for the Kharif season. However, a positive correlation (r=0.20, r=002 r=0.20 for GDD, HTU and PTU, respectively) with yield was observed for 15 June sowing Maize.

CONCLUSIONS

1. Minimum significant GDD accumulation at various growth stages were observed at P3 sowing date It was 67.70, 874.20, 982.46 and 1566.27 at emergence, 75 % tasseling, 75% silking and at maturity respectively. Minimum significant GDD accumulation as affected by mitrogen level was observed at N2 level (938.62) for 75 % tasseling at N3 level (1055.69) for 75 % silking and 1624.23 at N2 level upto maturity. The result showed that minimum GDD accumulation was maximum significant (1067.21) at 75 % silking at S2 spacing and was 1628.77 at S1 spacing for 75 % tasseling.

2. Heliothermal unit was observed to be significantly minimum of 396.90 for P4 at emergence. For 75 % tasseling 75 % silking and at maturity a minimum of 4692.72, 5403.67 and 8967.66 respectively was observed at P3 planting date, respectively. The effect of nitrogen on HTU was observed to be significantly minimum of 6756.00 at 75% tasseling and 1150.6 at maturity for N2 mitrogen level while minimum of 7481.80 at 75% sillking was observed at N3 level. Significant, minimum HTU accumulation of 7636.77 was observed at S2 spacing level at 75% silking.

3. The minimum significant PTU accumulation was observed at 75 % tasseling (10968.8) and at maturity (19442.1 at P1 sowing date. Minimum significant PTU accumulation of 11941.9 and 11150.2 was observed at N2 level for 75 % tasseling and at maturity respectively. Minimum PTU accumulation of 20494.7 was observed at S1 level at maturity.

4. The effect of planting date, nitrogen level and spacing was found to be significant on photothermal index. A maximum significant HUE of 49.76 g 0C-1

day-1 was observed for P3 planting date Maximum significant effect of 48.05 g 0C-1 day-1 was observed at N2 level. The maximum significant HUE of 42.65 g 0C-1 day-1 was observed at S1 level.

5. The correlation - regression analysis showed that PTU provided better estimates for emergence (r = 0.932) while GDD estimated 75 % tasseling (r = 0.999), 75% silking (r = 0.999) and maturity (r = 0.94) more accurately than HTU and PTU. The thermal indices i.e. GDD, HTU and PTU were negatively correlated with yield (r = 0.253 for GDD; r = -0.085 for HTU and r= -0.251 for PTU, respectively).

6. The study showed that optimum planting date was 15 June (P3), optimum nitrogen level was 120 kg N/ha (N3) and optimum intra-row spacing was 20 cm (S2) respectively. The correlation regression studies showed that GDD provided more accurate estimate of different developmental stages as compared to HTU and PTU. Thermal indices were observed to be negatively correlated with yield for maize in the kharif season but was positively correlated with yield observed for 15 June sowing (P3).

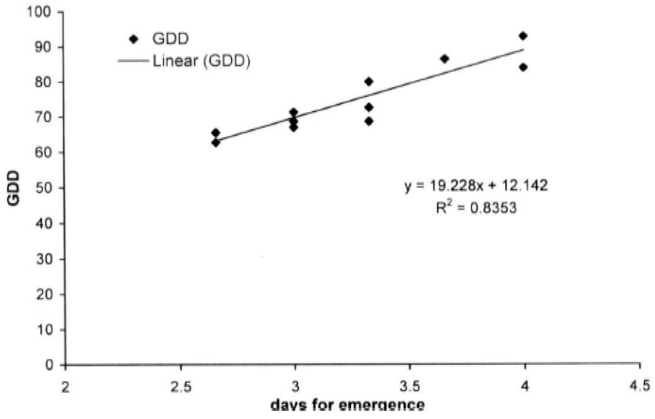

Fig. 1a Regression of GDD on days for emergence for maize for maize crop (2011)

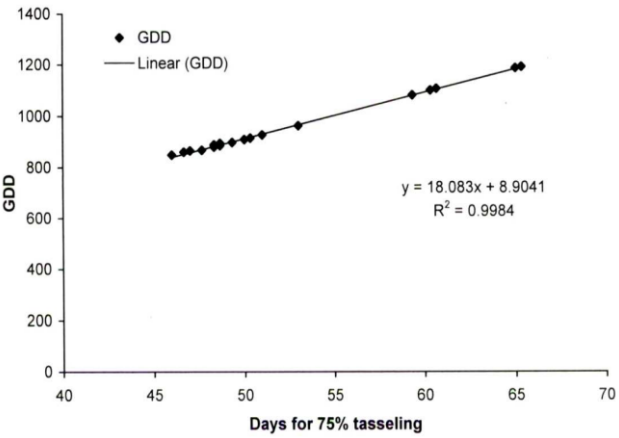

Fig. 1b Regression of GDD on days for 75% tasselling for maize crop (2011)

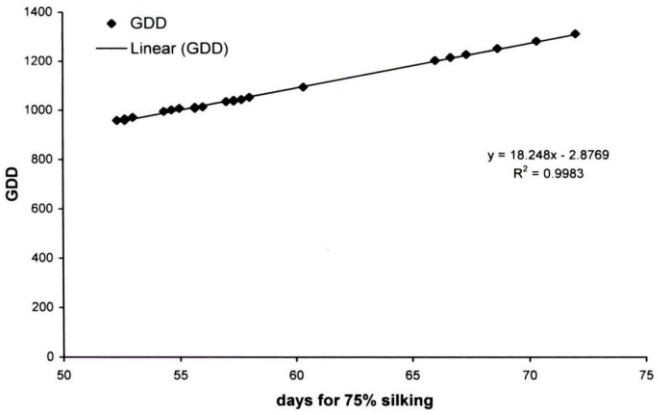

Fig. 1c Regression of GDD on days for 75% silking for maize crop (2011)

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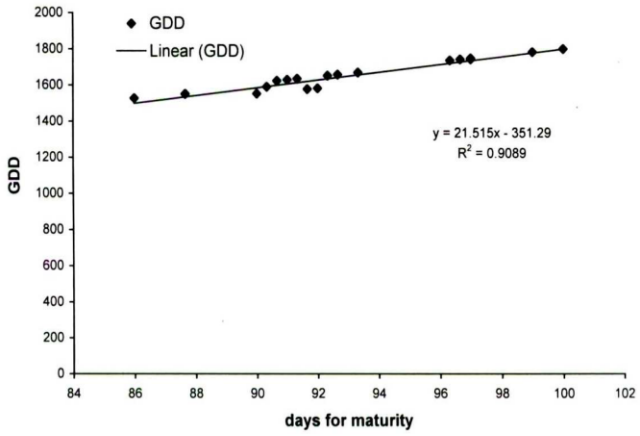

Fig. 1d Regression of GDD on days for maturity for maize crop (2011)

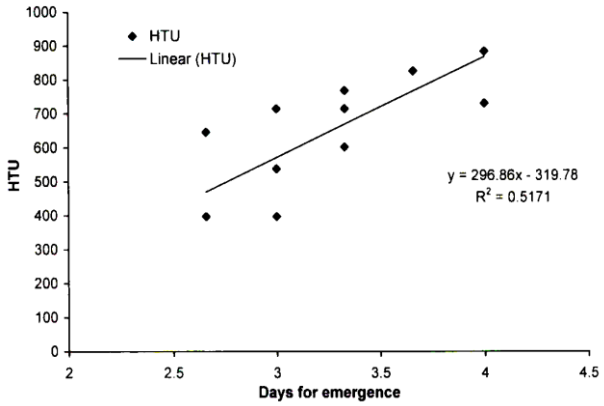

Fig. 2a Regression of HTU on days for emergence for maize crop (2011)

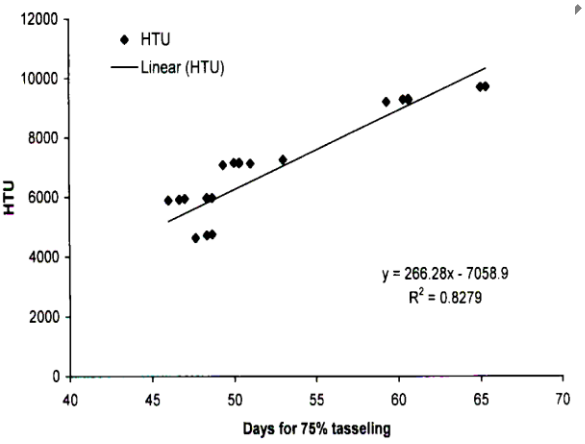

Fig. 2b Regression of HTU on days for 75% tasseling for maize crop (2011)

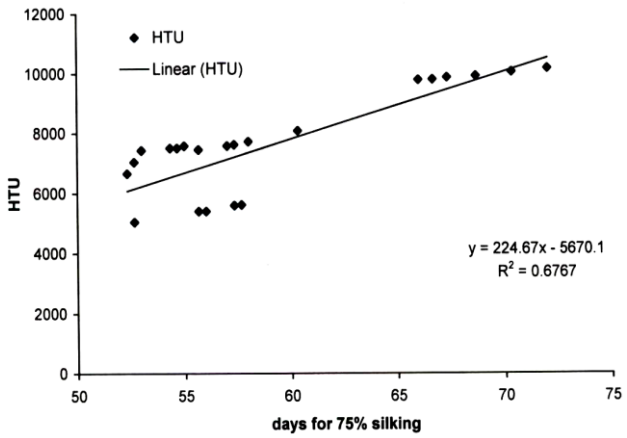

Fig. 2c Regression of HTU on days for 75% silking for maize crop (2011)

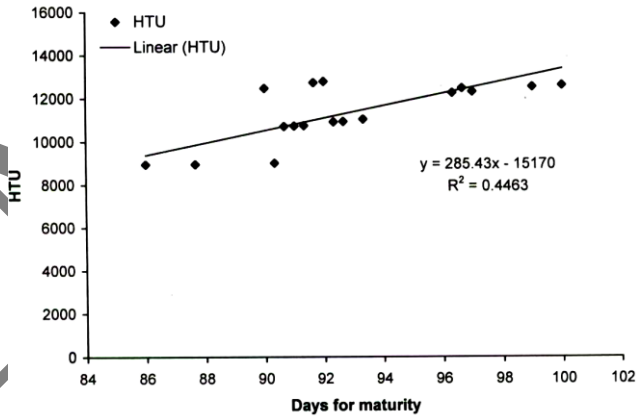

Fig. 2d Regression of HTU on days for maturity for maize crop (2011)

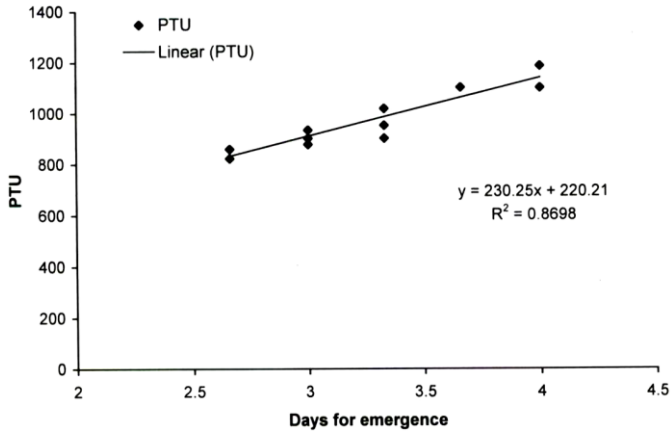

Fig. 3a Regression of PTU on days for emergence for maize crop (2011)

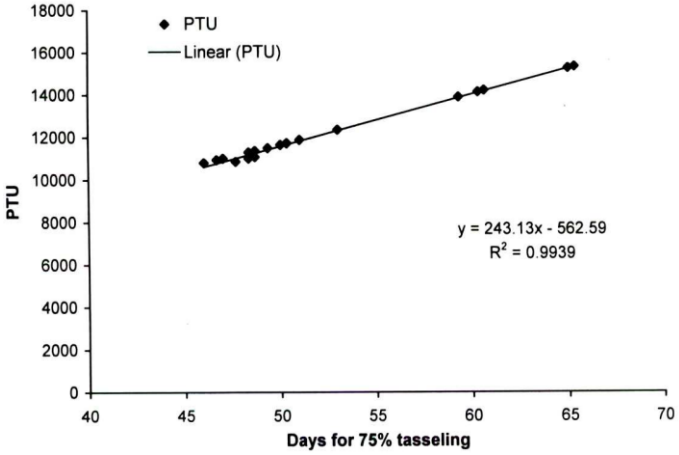

Fig. 3b Regression of PTU on days for 75% tasseling for maize crop (2011)

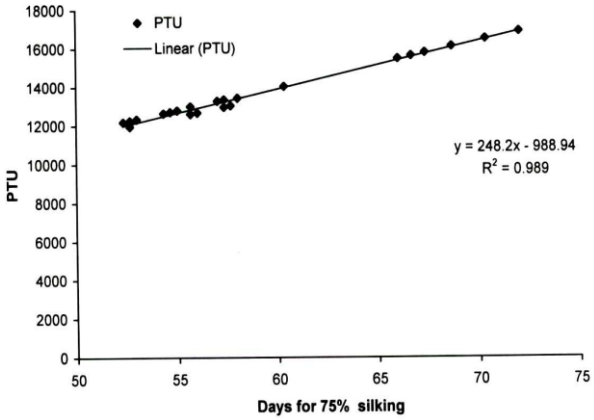

Fig. 3c Regression of PTU on days for 75% silking for maize crop (2011)

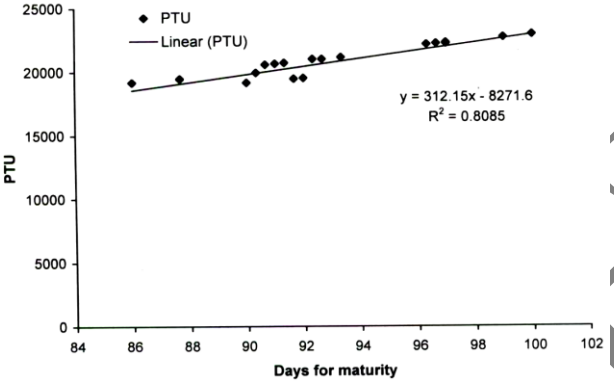

Fig. 3d Regression of PTU on days for maturity for maize crop (2011)

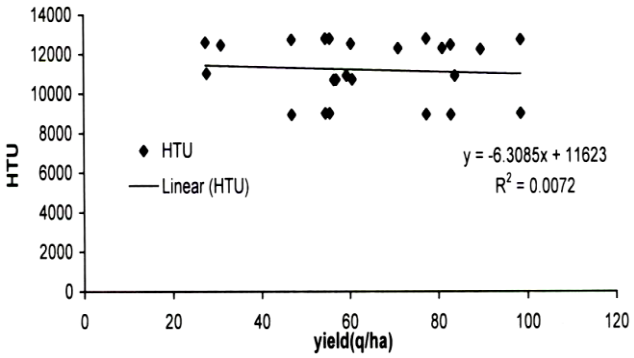

Fig. 4b Regression of HTU on yield of maize crop (2011)

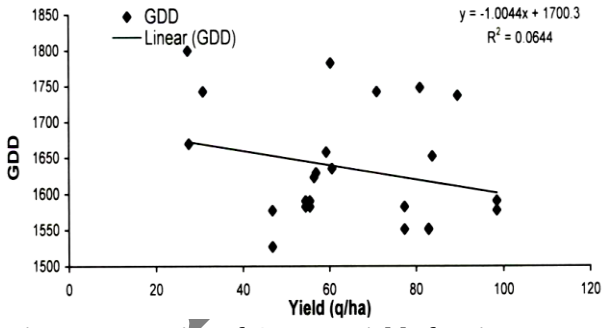

Fig. 4a Regression of GDD on yield of maize crop (2011)

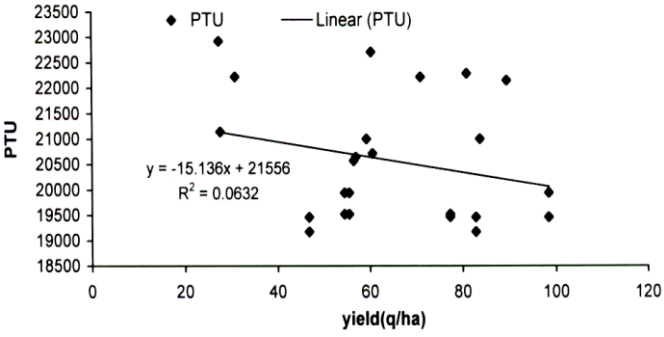

Fig. 4c Regression of PTU on yield of maize crop (2011)

Table 1: Photo-thermal index and heat use efficiency of maize crop for the year 2011

Treatments	Photo-thermal Index			Heat Use efficiency (g^0C^{-1} day $^{-1}$)
	Emergence to 75% tasseling	75% tasseling to 75% silking	75 silking to maturity	
Planting dates				

P_1	28.70	30.50	27.81	35.03
P_2	29.76	29.58	27.65	38.06
P_3	30.15	28.72	31.81	49.76
P_4	27.96	28.35	32.44	42.07
C	0.06	0.11	0.05	0.96
C.D. at 5%	0.19	0.35	0.17	3.14
Nitrogen Level				
N_1	29.18	28.99	29.14	26.10
N_2	29.13	29.34	30.41	48.85
N_3	29.13	29.53	30.23	48.74
S.Em±	0.04	0.07	0.04	0.99
C.D. at 5%	Ns	0.21	0.12	2.96
Row spacing				
S_1	29.17	29.28	29.60	42.65
S_2	29.12	29.30	30.25	39.81
S.Em±	0.02	0.08	0.03	0.62
C.D. at 5%	Ns	Ns	0.09	1.83

Ns = Non significant