Journal of Agrometeorology 10(2) : 204- 208 (Dec. 2008)

Heat and radiation use of chickpea(*Cicer arietinum L*) cultivars under varying sowing dates

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ABSTRACT

A field experiment was conducted during rabi (winter) season of 2004-05 and 2005-06 to study the heat and radiation use of chickpea cultivar in sandy loam soil at Faizabad,(Uttar Pradesh, India). The experiment consisted of three sowing dates viz sowing on Oct 20, Nov 05 and November 20 with four varieties viz. K-850, Awarodhi, Uday and Radhey. Results revealed that sowing on Nov 05 produced significantly higher yield attributes as well as related higher heat and radiation use efficiencies. The dry matter accumulation and number of branches/plant were higher in K-850 followed by Radhey while their lower values were obtained in Uday variety of Chickpea. Day temperature was highly correlated (R^2=0.79) with dry matter than night temp. (R^2=0.68). Highest dry matter was recorded at day temperature 29.4 ^oC, night temp. 22.4 ^oC and average temp. 25.9 ^oC.

Key words: Growing degree days, radiation/ heat use efficiency, chick pea.

Chickpea, commonly known as Gram, Chana and Bengal gram is grown in India as post monsoon winter season (*rabi*) crop as it requires cool and dry weather for optimum growth. The crop is predominantly grown under rainfed condition and is raised mainly on conserved soil moisture. Optimum sowing temperature and selection of improved varieties play a remarkable role in exploiting the yield potential of crop under particular agro-climatic conditions. Sub-optimal photothermal regimes during crop growing season are known to have profound effect on crop productivity. The selection of optimum sowing time to take maximum advantage of environmental conditions during growth increases the yield of crops. The change in sowing dates causes varied weather conditions especially in terms of the thermal requirement and radiation received by the crop canopy. The productivity of chickpea in eastern U.P. is quite below the national average, which needs to be improved by resource management (Shendge *et al*., 2002). Keeping above facts in view, the present experiment was under taken.

MATERIAL AND METHODS

A field experiment was conducted during *rabi* seasons of 2004-05 and 2005-06 at N.D.U.A.T., Kumarganj, Faizabad(U.P.) in factorial randomized block design with twelve treatment combinations comprising of three sowing dates viz. crop sown on October 20 with temperature 25.7^{0}C (D_1T_1), crop sown on November 05 with temperature 23.1^0 C ($D_2 T_2$) and crop sown on November 20 at 20.7 ^{o}C temp. ($D_3 T_3$) along with four varieties viz. K-850 (V_1), Awarodhi (V_2) Uday (V_3) and Radhey (V_4). Experiment was replicated three times. Geographically, the experimental site is situated at 26^0 47' N latitude, 82^0 12' E longitude and at an altitude of 113 meters above mean sea level in the North Indo-gangetic plain. Sowing of chickpea was done in rows 30 cm apart. A uniform dose of 20 kg N + 40 kg P_2O_5 ha^{-1} was applied as basal through urea and SSP.

Day and night temperature were calculated following Venkatraman (1968).

Day temperature = Tmax – 0.4 (Tmax- Tmin)

Night temperature= Tmin + 0.4 (Tmax- Tmin)

Where Tmax, Tmin are maximum and minimum temperatures respectively.

$$\text{Average temperature} = \frac{\text{day + night temperature}}{2}$$

Growing degree days at different phenological stages were calculated by using base temperature of

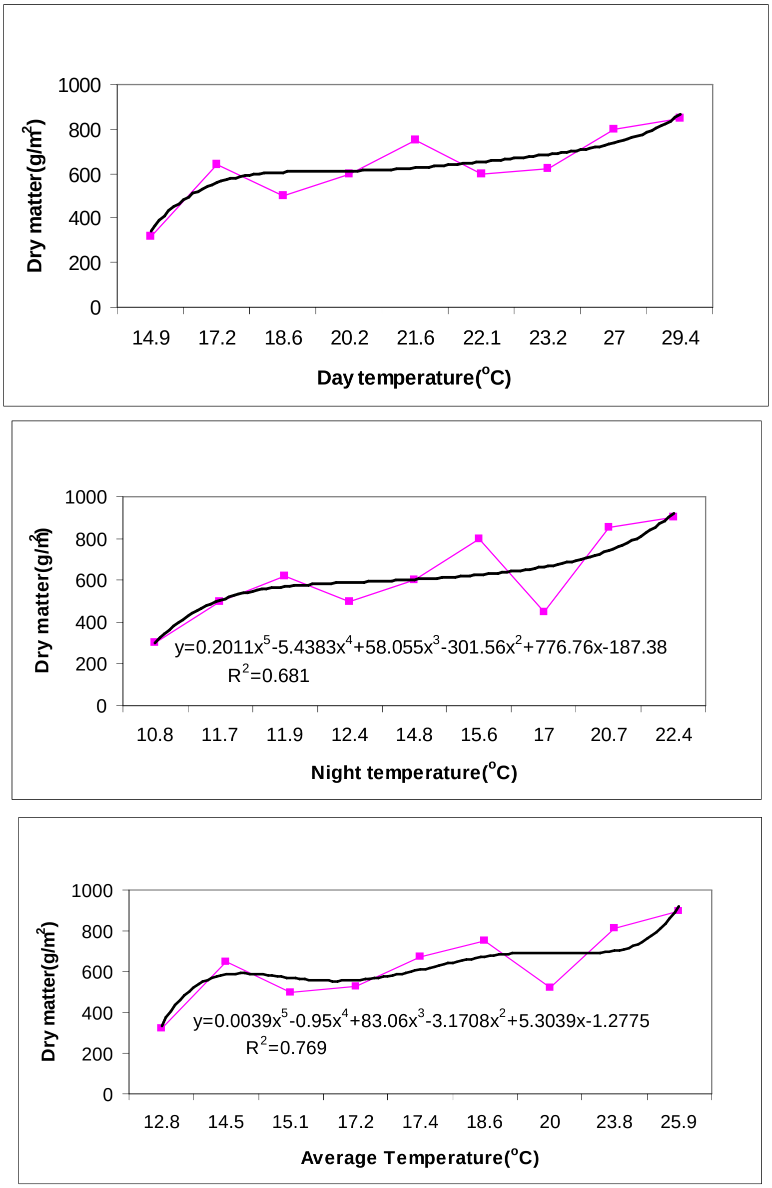

Fig. 1 : Relationship between day, night, average temperature and dry matter of Chickpea

at ground surface within the crop. The sensor was kept in inverted position within and above the canopy for measuring the reflected PAR.

APAR was determined by using the formula given by Asrar *et al*, (1989)

APAR= (PARo + RPARs) - (TPAR + RPARc)

Where,

PARo = Incident PAR above canopy

TPAR = Transmitted PAR from canopy

RPARs = Reflected PAR from soil

RPARc = Reflected PAR from canopy

Radiation use efficiency (RUE) is the dry matter production per unit of photo synthetically active radiation intercepted by the crop.

$$RUE = \frac{\text{Total dry matter (g m}^2)}{\text{APAR (MJ M}^2)}$$

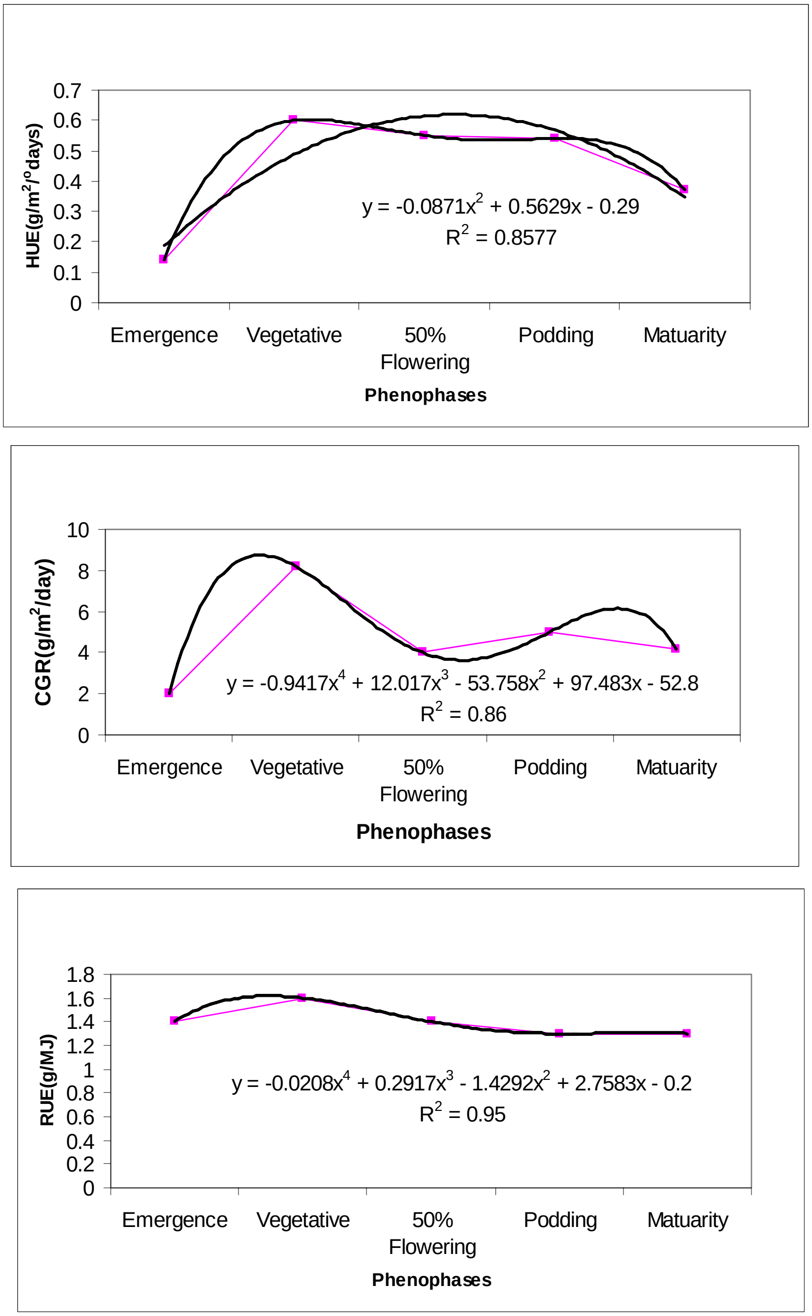

Fig.2 : Temporal variation of phenophases with HUE,CGR and RUE of Chickpea sown on November 05.

5^0C (Nuttonson, 1955)

Heat use efficiency (HUE) was calculated as:

$$HUE = \frac{\text{Total dry matter (g m}^2\text{)}}{\text{Accumulated heat unit } (^0\text{Cdays})}$$

Radiation measurement was made phenophase wise in each plot at mid noon between 12 Noon to 2 PM when solar intensity is assumed to be maximum. Photosynthetically active radiation ((PAR) was computed using the linear relation obtained from line quantum sensor and digital lux meter. The PAR were recorded by keeping the sensor above the canopy and

Table 1: Duration of phenological stages (days) and ÓGDD (Day °C) in chickpea as affected by sowing dates

Sowing dates	Phenophases		
	Emergence	Vegetative	50% flowering
Oct 20	6 (106)	112 (1352)	125 (1614)
Nov 05	7 (119)	102 (1217)	120 (1465)
Nov 20	8 (119)	93 (1013)	111 (1304)

Table 2: Yield and yield attributes of chickpea as affected by sowing dates

Sowing dates	No. of pods/ plant	No. of seeds/ plant	No. of seed/ pod	1000 seed weight (g)	Volume of 100 seed (cc)	Seed yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
Oct 20	64.6	104.2	1.6	285.7	182.8	23.5	53.8	44.7
Nov 05	70.8	135.9	1.9	289.5	207.3	24.5	55.3	44.3
Nov 20	58.7	86.8	1.5	276.5	276.4	20.1	51.4	39.0
SEm±	1.56	2.71	0.031	6.602	4.52	0.51	1.21	0.76
CD at 5%	4.58	7.96	0.09	NS	13.27	1.50	3.6	2.25

RESULTS AND DISCUSSION

Effect of sowing date

Delay in sowing by one month (November 20) reduced the vegetative phase by 19 days over October 20 sowing and 9 days over November 5 sowing. (Table 1) however, maximum days from sowing to maturity (166 days) were recorded in October 20 sowing while crop sown on November 20 took 146 days for maturity.

GDD

The maximum heat units from sowing to maturity 2318°c days were recorded in Oct.20 sowing and minimum heat unit accumulation 1864 °C days in Nov. 20 sowing. GDD during emergence and vegetative phase were higher in November 20 sown crop while during maturity GDD was lower in November 20 due to shorter growth duration. Relationship between day/ night temperature/ average temp. and dry matter accumulation of Chickpea sown on Nov 5 revealed that dry matter accumulation increased with increase in day temp, night temp, and average temp.(Fig.1). However day temperature was highly correlated (R^2=0.79) with dry matter than night temp. (R^2=0.68). Highest dry matter was recorded at day temperature 29.4 °C, night temp. 22.4 °C and average temp. 25.9 °C respectively.

Growth attributes of cultivars

The length and maturity periods for all the cultivars was more or less similar (153 to 158 days) but the length of phenophasic durations were different for different varieties due to changes in sowing time. The dry matter accumulation and number of branches/ plant were higher in K-850 followed by Radhey while their lower values were obtained in Uday variety of Chickpea.

Yield

The sowing date had significant effect on yield and all yield attributes of chickpea except 1000 seed weight (Table 2). Significantly higher values were recorded when crop was sown on Nov.5. Though harvest index was slightly higher in Oct.20 sowing, lowest harvest index was recorded in the Nov.20 sowing

Table 3: Heat use efficiency (g m^{-2} $^{o}day^{-1}$) of chickpea as affected by sowing dates

Sowing dates	Phenophases				
	Emergence	Vegetative	50%flowering	Podding	Maturity
Oct 20	0.10	0.57	0.50	0.49	0.35
Nov 05	0.14	0.60	0.55	0.54	0.37
Nov 20	0.10	0.44	0.37	0.30	0.29

Table 4: Radiation use efficiency (g MJ^{-1}) of chickpea as affected by sowing dates.

Sowing dates	Phenophases				
	Emergence	Vegetative	50%flowering	Podding	Maturity
Oct 20	1.30	1.52	1.31	1.34	1.27
Nov 05	1.45	1.67	1.49	1.38	1.34
Nov 20	1.28	1.46	1.28	1. 24	1.22

attributable to sub-optimal thermal regime.

HUE, CGR and RUE

Relatively higher HUE, CGR and RUE were noticed in Nov.5th treatment which yielded higher biomass at all growth stages. Maximum HUE, CGR and RUE were obtained with sowing done on Nov. 5th. Temporal variation of phenophases with HUE, CGR and RUE of chickpea sown on Nov. 5 are given in Fig. 2. Heat use efficiency increased successively from emergence to flowering phase with $R^2 = 0.85$. CGR of chickpea after vegetative stage was decreased successively. Radiation use efficiency obtained during vegetative phase was comparatively higher than at reproductive phase mainly due to higher HUE and CGR.

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Received: June 2007; Accepted: August 2008