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Variations in heat and radiation use efficiency of green gram as influenced by sowing dates and chemical sprays

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ABSTRACT

Experiments were conducted in two summer seasons (1999 and 2000) to understand the influence of sowing dates and chemical sprays on phenology, heat use efficiency (HUE) and radiation use efficiency (RUE) in green gram. The spraying treatments affected the total biomass accumulation and yield. HUE was maximum in Salicylic acid 50ppm spray treatments.

Key Words: Greengram, Heat use efficency, Radiation use efficiency.

Plant growth ceases when temperature exceeds a certain value or drops below a critical minimum regardless of favourable moisture and light (Rao *et al*, 1999). Thermal time is an independent variable to describe plant development (Dwyer and Stewart, 1986) and it has been used as a tool for characterizing thermal responses in different crops (Rajput *et al*, 1987; Billore *et al*, 1992). Light levels also have a profound influence on plant growth. Crops sown on different dates are exposed to different solar duration during the season and this may influence Radiation use efficiency (RUE) through its effects on radiation transmission (Khichar *et al*, 2000). The result of a study on the effect of different sowings and chemical sprays on phenology, HUE and RUE of green gram is presented here.

MATERIALS AND METHODS

The experiment was conducted in two summer seasons (March 1999, and February 2000) at Deras farm, Bhubaneswar (20° N, 85° 38'E). The station experiences a hot humid summer. Green gram var K-56 was sown in paddy fallow following recommended package of practices. The crop was sprayed with no spray control (T_1), water (T_2) salicylic acid 50ppm(T_3), Cycoceal 100ppm (T_4), Kaolinite 6% (T_5), at 30 days. Green gram was sown on two dates D_1 (1/02/2000) and D_2(12/02/2000) during 2000 and D_1 (10/03/99) and D_2 (20/3/99) during 1999. The experiment was laid out in randomized block design with three replications. Plant samples were collected from each replication for aboveground dry mass. Growing degree days were computed by using base temperature of 7 °C (Ghadekar and Sethi, 1986).

The heat use efficiency (HUE) and radiation use efficiency (RUE) corresponding to the day of maximum biomass accumulation were computed

using the following formula

HUE = biomass (g m^{-2}) / Accumulated heat units

RUE = biomass (g m^{-2}) / Cumulative absorbed PAR

RESULTS AND DISCUSSION

Green gram took 58 and 55 days (D_1 and D_2) and 68 and 60 days to attain physiological maturity during 1999 and 2000 respectively. As the sowing date was delayed growth occurred under higher temperatures with reduction (Table 1) in phenophase duration. The crop sown in 2000 took higher number of days compared to 1999 to attain physiological maturity.

Accumulated heat units to attain different crop growth stages from sowing to maturity for green gram under different sowing dates (Table 3) showed that a higher GDD was observed in early sown crop compared to late sown crop (1382 during 1999 and 1290 during 2000). The crop sown during 1999 accumulated a higher GDD for emergence and to reach two leaf stage. But during later crop stages in 1999 GDD was less compared to that of 2000.

The spraying treatments effected significant changes in the total biomass accumulated (Table 2). The crop sown during March in year 1999 experienced higher temperature at the time of physiological maturity as it coincided with last week of April and second week of May. The crop yielded 1.7-4.29 q ha^{-1} during 1999 and 1.3 to 2.47 during 2000. The yield reduction in second sowing was 13.9% over first sowing during 1999 and 9.7% in 2000 compared to first sowing (Table 2). This was probably due to the higher temperatures that prevailed at seed filling and maturity phases of late sown crops. The reduction in total dry weight towards reproductive part in the late sown might have resulted in lower yield as compared to first sown crop.

HUE of green gram at maximum accumulation level as influenced by sowing dates and chemical sprays are computed and presented in Table 3. It was observed that salicylic acid 50ppm, cycocea1100ppm and Kaolinite 6% v/v showed higher HUE compared to water spray.

The results (Table 3) revealed that RUE varied between 0.09 to 0.2412 g MJ^{-1}. These values are less compared to the RUE in other crops. Studies conducted in different crops suggest that the crops that produce low energy products (high carbohydrates) have high RUE (Sinclair and Dewitt, 1975). So in most grain legumes and pulses RUE were reported less than 0.8g MJ^{-1} (Sinclair and Muchow 1999). The crop was grown in receding soil moisture condition with out any irrigations. The treatment of sprays might have helped in increasing RUE. This could be due to the maintenance of water status inside the plants by salicylic acid spray and reflection of the radiation by reflectance material, kaolinite there by reducing the heat load with in the plants (Edna *et al.* 2000). The present study shows that any measure to improve interception of solar radiation and maximising photosynthetic efficiency like salicylic acid spray could

Table 1: Phenological duration (days) and accumulated heat units(GDD) as affected by sowing dates

Phenological stages	1999				2000			
	D_1		D_2		D_1		D_2	
	Days	GDD	Days	GDD	Days	GDD	Days	GDD
Emergence	2	60	2	66	2	44	2	45
Two leaf stage	7	207	9	278	5	130	7	177
50% flowering	21	684	17	665	35	754	30	767
Pod stage	18	825	20	906	18	880	16	910
Physiological maturity	10	1382	7	1270	8	1290	6	1243

Table 2: Influence of chemical sprays and sowing dates on total dry matter (TDM, g m^{-2}) and yield (g m^{-2}) in green gram during 1999 and 2000

Treatments	1999				2000			
	D_1		D_2		D_1		D_2	
	TDM	Pod yield	TDM	Pod yield	TDM	Pod yield	TDM	Pod yield
No spray	75.0 b *	12.9 c	62.0 c	12.9 d	62.0 d	13.1 c	59.5 c	14.5 c
Water spray	65.0 b	12.9 c	72.0 c	12.9 d	65.5 d	12.3 c	75.5 b	15.0 c
Salicylic acid	85.0 a	43.0 a	89.5 b	37.0 b	136.5 a	24.7a	111.5 a	22.3 a
Cycocel	95.0 a	27.0 b	73.0 c	32.7 c	113.5 b	22.9 a	100.5 a	16.8 b
Kaolinite	91.5 a	28.0 b	108.0 a	42.8 a	111.0 c	20.6 b	111.0 a	13.7 c

* Mean values separated by DMRT at 5% level of significance. In a coloum means followed by a common letter are not significantly different at 5% level.

Table 3: HUE, RUE (g MJ^{-1}) and PAR (MJ m^{-2}) in green gram as influenced by dates of sowing and chemical sprays

Treatments	1999				2000			
	D_1		D_2		D_1		D_2	
	HUE	RUE	HUE	RUE	HUE	RUE	HUE	RUE
No spray	0.054 c	0.1330 c	0.048 d	0.1090 d	0.048 c	0.1095 d	0.047 c	0.0900 d
Water spray	0.047 d	0.1152 d	0.056 c	0.1268 c	0.050 c	0.1157 c	0.060 b	0.1152 c
Salicylicacid	0.061 b	0.1507 b	0.070 b	0.1576 b	0.105 a	0.2412 a	0.089 a	0.1702 a
Cycocel	0.068 a	0.1680 a	0.057 c	0.1285 c	0.087 b	0.2006 b	0.080 a	0.1534 b
Kaolinite	0.066 a	0.1622 a	0.085 a	0.1902 a	0.086 b	0.1960 b	0.089 a	0.1694 b
PAR (MJ m^{-2})	563.90		567. 78		565.72		655.07	

Mean separartion by DMRT 5% level. Values in a column followed by a common letter are not significantly different at 5% level

improve crop growth, yield and RUE even under receding soil moistures.

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