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Research Article

Effect of Sowing Dates on Heat Requirements of Different Cultivars of Green Gram (*Vigna radiata L.*)

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ABSTRACT

Green gram being a low-input crop, it has an immense importance and the growth and yield of green gram are greatly affected by the climate variability. Sunlight and heat (measured through temperature) significantly affect the productivity of green gram. Therefore, in order to evaluate the efficacy of green gram varieties and date of sowing an experiment was carried out during *kharif,* 2018 at the Instructional-Cum-Research (ICR) Farm of Assam Agricultural University, Jorhat to find the optimum date of sowing and to evaluate the suitable variety of green gram under agroclimatic condition of Jorhat. The experiment was conducted in split plot design with four replications. Treatments comprised of three varieties *viz* SG-16, SG-20 and IPBM-02-3 in main plot and and three different dates of sowing *viz.* D1: (25thAug), D2: (10th Sep) and D3: (25th Sep) in sub plot. Growing degree days, Photo thermal units and Helio thermal units were computed using the daily meteorological data. The base temperature of 10°C was used for computation of Growing degree days (GDD) on daily basis. The results revealed that green gram crop which was sown on 25thAug *i.e* early sown green gram accumulated more heat units to attain physiological maturity as compared to late sown green gram thereby producing higher seed yield as compared to late sown green gram. Therefore, early sown green gram produced higher seed yield as compared to late sown green gram. Among the varieties, SG-20 accumulated more heat units resulting in higher seed yield than SG-16 and IPBM-02-3.

Key words: Varieties, Sowing dates, Growing degree days, Yield

Introduction

Green gram being a short duration crop suits well to the cropping system and it is the major cultivated pulse crop in the north eastern states. It acts as one of the protein supplier to the cereal dominated diet of many people. In Assam it is used in religious ceremonies as *prasads* apart from using it as a pulse crop. Temperature is one of the primary microclimatic factors driving the rates of growth. Influence of temperature on phenology and yield of crop plan can be studied under field condition through accumulated heat unit system (Haider *et al*., 2003). Shift in sowing dates directly influence both thermo and photoperiod and consequently a great bearing on the phasic development and partitioning of dry matter (Leela *et al.*, 2012). Rate of plant growth and development is dependent upon temperature surrounding the plant and each species has a specific temperature range represented by a minimum, maximum, and optimum. The number

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of days required for cultivars to reach maturity depends primarily on location, date of planting and temperature. Due to variations in daily minimum and maximum temperatures from year to year and between location, number of days from planting to physiological maturity varies. Meteorological indices *viz.* growing degree days (GDD), photo-thermal unit (PTU), helio-thermal unit (HTU) which are based on air temperature are used to describe changes in phenological behavior and growth parameters (Prakash *et al.*, 2015). The temperature based agrometeorological indices provide a reliable prediction for crop development and yield. Influence of temperature on phenology and yield of crops can be studied under the field condition through accumulated heat unit system (Pandey *et al.*, 2010). Therefore, in order to evaluate the efficacy of effect of sowing dates on heat requirements of different cultivars of green gram (*Vigna radiata L.*) an experiment was carried out during *kharif,* 2018 at the Instructional-Cum-Research (ICR) Farm of Assam Agricultural University, Jorhat to find out the heat units requirement for different green gram varieties, *viz.* SG-16, SG-20 and IPBM-02-3 under different dates of sowing in the agroclimatic condition of Jorhat.

Material and Methods

Study site

Experiment was conducted at the ICR (Instructional-Cum-Research) Farm of Assam Agricultural University, Jorhat during kharif seasons of 2018. The experimental site is situated at 26°47' N latitude and 94°12' E longitude at an elevation of 87 m above mean sea level. The site is characterized by sub-tropical belt with hot and humid summers and cold and dry winters. The mean annual rainfall is 1900mm, of which 62.6 per cent is received during south-west monsoon from June to September. The monthly average maximum and minimum temperatures vary from 22.6 to 32.7°C and 9.7 to 25.2°C, respectively. The soil of the experimental site was sandy loam. The meteorological data was recorded at Meteorological Observatory of Assam Agri-cultural University, Jorhat during crop growing season.

Experimental treatment

The experiment was conducted in Split plot design with four number of replications. Treatments comprised of three varieties *viz* SG-16, SG-20 and IPBM-02-3 in main plot and and three different dates of sowing *viz.* D1: (25thAug), D2: (10th Sep) and D3: (25th Sep) in sub plot. Crop was sown with spacing 30 × 10 cm.

Growing degree days (GDD)

A degree-day (°C), or a heat unit, is the departure from the mean daily temperature above the minimum threshold (base) temperature. GDD was calculated according to the equation. (Mali *et al.,* 2000).

$$GDD = \frac{T_{Max} + T_{Min}}{2} - T_{base}$$

Where, T_{max} and T_{min} represent the daily maximum and minimum temperatures and T_{base} is the base temperature or minimum threshold temperature taken as 10(°C) for green gram (Bharti *et al.,* 2017).

Photothermal units (PTU)

Photo-thermal Unit (°C days hrs) were computed by taking the product of GDD and corresponding day length for that day (Nuttonson, 1955). This can be mathematically represented using the following formula:

$$PTU = \Sigma\ (GDD \times N)$$

where, GDD = Growing degree days, N = Maximum possible sunshine hours or day length (hrs).

Heliothermal units (HTU)

A Helio-thermal unit (°C day hrs) is the product of the growing degree-days and the corresponding actual bright sunshine hours. HTU is calculated using following expression:

$$HTU = \Sigma\ \{GDD \times BSS\ (n)\}$$

where, GDD = growing degree days, BSS (n) = bright sun shine hours (hrs)

Data analysis

Data on seed yield was used to perform analysis of variance to determine the effect of treatments. Data were analyzed with analysis of variance (ANOVA) as standard method. Treatments were compared by computing the F-test. The significant differences between treatments were compared pare wise by critical difference at the 5% level of probability.

Results and Discussion

Accumulated growing degree day (°C day)

The accumulated growing degree days (GDD) by different green gram cultivars under different microclimatic regimes are shown in Table 1. During the kharif, 2018 crop growth period, the total accumulated growing degree-days recorded in D1, D2 and D3 were (1131 to 1157) degree-days, (1048 to 1058) degree-days and (925 to 959) degree-days respectively. It was observed that there was successively decreased in the accumulated growing degree-days right from D1 through D3 in all the crop growth stages. Among the phonological stages all the cultivars accumulated maximum GDD during vegetative stage. Highest accumulated growing degree day was observed under D1 sown in variety SG-20 (1157 degree-days) followed by D2 (1058 degree days) and D3 (959 degree days) respectively. In general the accumulated growing degree day values decreased with delayed sowing and it may be due to maximum air temperature prevailed at sowing time. These results are in general agreement with the findings of (Gill *et al*., 2018; Mane *et al.*, 2017). Under different dates of sowing the trend of GDD accumulated by all the cultivars was in line with the trend observed in the yield. Both the value of GDD and seed yield was observed to be decreased with the delay in sowing.

Accumulated photo thermal units (°C day hour)

Accumulated photo thermal unit (PTU) by green gram cultivars under different dates of sowing are shown in Table 2. Accumulated photo thermal unit recorded in D1, D2 and D3 were (13259-13546°C day hour), (11916-12020°C day hour) and D3 (10276-10656°C day hour)

Table 1. Accumulated growing degree days GDD at different growth stages of gram gram under different sowing dates

Phenological stages	SG-16			SG-20			IPBM-02-3		
	D1	D2	D3	D1	D2	D3	D1	D2	D3
Vegetative	574	544	497	609	575	527	626	589	539
Reproductive	310	291	259	289	273	239	288	246	217
Maturity	247	213	177	246	219	193	259	223	187
Total period	1131	1048	925	1157	1058	959	1144	1023	934

D1: 1st Date of sowing (25th Aug) ; D2: 2nd Date of sowing (10th Sep) ; D3: 3rd Date of sowing (25th Sep)

Table 2. Accumulated Photothermal units (PTU) at different growth stages of gram gram under different sowing dates

Phenological stages	SG-16			SG-20			IPBM-02-3		
	D1	D2	D3	D1	D2	D3	D1	D2	D3
Vegetative	7013	6371	5569	7443	6707	5896	7637	6863	6035
Reproductive	3531	3202	2854	3257	3002	2632	3235	2709	2238
Maturity	2715	2344	1952	2719	2405	2128	2846	2448	2056
Total period	13259	11916	10276	13546	12020	10656	13409	12009	10375

D1: 1st Date of sowing (25th Aug); D2: 2nd Date of sowing (10th Sep); D3: 3rd Date of sowing (25th Sep)

Table 3. Accumulated Heliothermal units (HTU) at different growth stages of gram under different sowing dates

Phenological stages	SG-16			SG-20			IPBM-02-3		
	D1	D2	D3	D1	D2	D3	D1	D2	D3
Vegetative	2170	2275	2213	2204	2357	2501	2204	2364	2502
Reproductive	1168	1548	1635	1142	1491	1347	1188	1459	1345
Maturity	1364	1243	1155	1459	1296	1349	1484	1384	1228
Total period	5282	5066	4932	5329	5107	4996	5196	4912	4829

D1: 1st Date of sowing (25th Aug) ; D2: 2nd Date of sowing (10th Sep) ; D3: 3rd Date of sowing (25th Sep)

respectively. Among phenological stages, all the cultivars accumulated maximum PTU during vegetative stage. Highest accumulated photo thermal unit was observed under 25th Aug (D1) sown in variety SG-20 (13546°C day hour). The accumulation of PTU decreased with the delay in date of sowing. These findings are also in conformity with findings of Bankar *et al.* (2018).

Accumulated helio-thermal unit (°C day hour)

The heliothermal unit requirements for total growth phases were found to decrease with delay sown crop (Table 3). These results are in general agreement with the findings of Bankar *et al.* (2017). Highest accumulated helio thermal units was observed under D1 sown in variety SG-20 (5329°C day hour) followed by D2 (5107°C day hour) and D3 (959°C day hour) respectively. Among phenological stages, all the cultivars accumulated maximum HTU during vegetative stage. Under different dates of sowing the trend of HTU accumulated by all the cultivars was in line with the trend observed in the seed yield. Both the value of HTU and seed yield was observed to be decreased with the delay in sowing.

Seed yield

The data on seed yield as affected by different growing environments are presented in the Table 4. It is evident from the table that the seed yield was significantly influenced by different growing environments. The highest seed yield was recorded for crop sown during D1 (787 kg/ha) followed by D2 (655 kg/ha) and the lowest seed yield was observed when crop was sown during D3 (537 kg/ha). The maximum seed yield in D1 may be due to higher GDD, PTU and HTU than the rest of sowing dates. The growing degree day, photo-thermal unit for entire crop growing period decreased with subsequent delay in sowing. Delay in sowing times negatively influenced its yield attributing parameters therefore, early sowing produced higher seed yield than late sowing. These results are in general agreement with the findings of Jiotode *et al.* (2017).

Table 4. Seed yield (kg/ha) of green gram varieties under different dates of sowing

Varieties	Seed yield (kg/ha)			
	D1	D2	D3	Mean
SG-16	785	636	524	648
SG-20	816	707	580	701
IPBM-02-3	761	621	508	630
Mean	787	655	537	
	SE	CD at 5%		
Sowing Date	12	25.41		
Varieties	9.63	24.01		

Conclusions

The results of the present investigation revealed that higher seed yield along with the heat units *viz*; accumulated growing degree days, photo thermal unit, helio thermal unit, were recorded maximum in crop sown on 25th Aug(D1) as compared to on 10th Sep (D2) and 25th Sep(D3) sown crop. Therefore, it can be concluded that early sowing dates is better than delayed sowing. Among the variety SG-20 showed significantly higher yield than the rest of varities in all the sowing dates and performing overall best in terms of utilization of different heat units *i.e* GDD, PTU and HTU which means that the cultivar SG-20 is more efficient in utilizing heat and sunlight available for growth, development and yield.

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