Original Research Article

<https://doi.org/10.20546/ijcmas.2021.1002.150>

Effect of Heat Units on Growth and Yield of Groundnut Varieties under Different Planting Methods in Summer Season

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ABSTRACT

Keywords

GDD, HTU,
Groundnut,
Varieties and Land
configurations

Article Info

Accepted:
12 January 2021
Available Online:
10 February 2021

A field experiment was conducted in the summer seasons of 2014 on three groundnut varieties (V₁-TAG-24, V₂-SB-XI and V₃-LGN-1) sown on four different land configurations (L₁- Ridges and furrow, L₂- Broad bed furrow, L₃ – Sara and L₄-Flat bed) at the research farm of Department of Agronomy, Vasantao Naik Marathwada Agricultural University, Parbhani. The experiment was laid out in a split plot design with three replications where the land configurations and the varieties were considered as main plot and sub plot treatments respectively. The objective of this experiment was to study the effect of heat units on growth and yield of groundnut in *summer* season as temperature increases GDD and HTU of crop increased and it depends on duration of varieties. Total GDD requirement of SB-XI is greater than TAG-24 and LGN-1. Bud emergence and pod emergence phases which might have played a crucial role in the yield of the crop and performed better in BBF and Ridges and Furrow land configurations.

Introduction

Among oilseed crops, groundnut occupies prime position in terms of acreage and production in India. Its high oil and protein content, ability to withstand water deficit conditions and remunerative price in market make it an attractive crop to farmers. Due to these agronomic and economic advantages it is an indispensable crop in the cropping pattern of Marathwada region of Maharashtra. India occupies first place in regard to acreage (6.40 M.ha.) and second in production (6.25 M.tones). In India during 2014 it was grown in an area of 55.27 lakh ha with total

production of 96.72 lakh tones and productivity 1804 kg/ha. About 80% of area under groundnut is concentrated in 5 states as Gujrat rank first in area and production of groundnut, it contributes 38% of total production of India followed by Andhra Pradesh 16%, Tamil Nadu 14% Rajasthan 9%, Maharashtra 8.22% and Karnataka 8%. In Maharashtra during 2014 area under groundnut was 2.67 lakh /ha, Production was 3.25 lakh tones and productivity was 1217 kg/ha. (www.indiastat.com).

In Marathwada weather conditions are prevailed during post monsoon season match

with the growth phases of groundnut i.e. warm weather (18-37 °C) expansive phenophase favours adequate vegetative growth and long cool period which restricts vegetative growth followed by warm period favours pod development.

Broad bed furrow provide favourable soil atmosphere by lowering the bulk density in the surface layer with low soil strength leading good root development, better nodulation.

Temperature is an important environmental factor influencing the growth and development of crop plants. Influence of temperature on phenology and yield of crop plants can be studied under field condition through accumulated heat units system (Bishnoi *et al.*, 1995). Temperature based agrometeorological indices such as Growing degree day (GDD), Heliothermal unit (HTU) and Thermal use efficiency (TUE) are very useful for predicting the growth and yield of crops.

The growing degree day (GDD) is a simple tool to find out the relationship between plant growth, maturity and mean air temperature. A degree day or a heat unit is the departure from the mean daily temperature above the minimum threshold temperature (Basu *et al.*, 2012). GDD requirement indicates the thermal status for the onset of a particular phenophase in the crop.

Importance of Heat Units (HU) in Crop Production

The amount of heat energy an organism accumulates over a period of time is often expressed as a “growing degree-day” (GDD). The growth rate of many organisms is controlled by temperature. Growers use a concept related to degree-days called growing degree-days (GDDs), sometimes called heat

Applications of HU in Crop Production

(i) Assess the suitability of a region for production of a particular crop.(ii) Determine the growth-stages of crops. (iii) Predict best timing of fertilizer or herbicide and plant growth regulator application. (iv) Estimate the heat stress on crops. (v) Predict the maturity (physiological) and harvest dates. (vi) Tool for managing growth regulators or harvest aids; (vii) Ideal unit in crop weather model.

Calculation of GDD

“Growing degree days” (abbreviated GDD or DD) is a way of assigning a heat value to each day. Growing degree days are calculated in each day using the maximum daily temperature (T_{max}), the minimum daily temperature (T_{min}), and a base temperature (T_{base}).

$$GDD = \frac{T_{max} + T_{min}}{2} - T_{base}$$

T_{base} – The base temperature or threshold temperature– is the temperature below which no growth takes place. This varies with different crops. Generally, the threshold temperatures are higher values for tropical crops and lower values for temperate crops.

Helio-thermal units (HTU)

The product of GDD and corresponding actual sunshine hours for that day were computed on daily basis as:

$$HTU = GDD \times \text{Actual Sunshine hours}$$

In present study, an attempt is made to predict growth and yield of groundnut based on GDD and HTU. Heat use efficiency of three varieties of groundnut under different planting methods in *summer* season.

Materials and Methods

A field experiment was conducted at research farm, Department of Agronomy, Vasant Rao Naik Marathwada Agricultural University, Parbhani, in *summer* season of 2014. The soil was medium black clayey in texture having bulk density 1.33 g cm^{-3} , Particle density 2.66 g cm^{-3} , Soil pH 8.07, EC 0.37 dsm^{-1} at 25°C , Organic carbon 0.34 g kg^{-1} , Available Nitrogen $190.61 \text{ kg ha}^{-1}$, Available Phosphorous 11.52 kg ha^{-1} , Available Potash $285.15 \text{ kg ha}^{-1}$.

The experiment was laid out in split plot design with three replications and 12 treatments. The main plot comprised three land configurations L_1 Ridges and furrow, L_2 Broad bed furrow, L_3 Sara and L_4 flat bed. Sub plot treatments varieties as V_1 -TAG 24, V_2 - SB-XI and V_3 -LGN-1. The gross plot size was $5.4 \text{ m} \times 4.2 \text{ m}$ and net plot size was $4.8 \text{ m} \times 3.8 \text{ m}$.

The sowing was done by dibbling method on 27th February 2014 at the spacing of $30 \times 10 \text{ cm}$. The recommended cultural practices and plant protection measure were undertaken. The recommended dose of fertilizer (25:50:00

kg NPK ha^{-1}) was applied at the time of sowing through urea and DAP. The rainfall received during crop growing season was 177.2 mm in 2014 *summer* season.

Results and Discussion

Growing degree days and Heliothermal Units required for different phenophases of three groundnut varieties are presented in table 1. In general long duration variety required more GDD as compared to short duration variety. The GDD requirement for different phenophases varied depending upon the duration of a particular phenophase. Maximum GDD requirement was observed in P_7 and P_8 (pod initiation to harvest) and the minimum was recorded in P_1 to P_2 (sowing to complete emergence) (Fig. 1–3 and Table 1–5).

Among the three varieties, as V_1 short duration GDD requirement was minimum in TAG-24 and SB-XI long duration GDD requirement was maximum in SB-XI and optimum in LGN-1. The variation in GDD requirement depends on the duration of a particular phenophase (Borreani *et al.*, 2007).

Table.1 Phenophases-wise requirement of GDD and HTU of different groundnut varieties

Phenological stages	TAG-24(V_1)		SB-XI(V_2)		LGN-1(V_3)	
	GDD	HTU	GDD	HTU	GDD	HTU
P_1	52	468	77	671	64	585
P_2	99	804	125	981	112	882
P_3	383	3251	571	4992	498	4289
P_4	843	7555	1005	8820	913	8176
P_5	1162	10418	1385	12463	1254	11375
P_6	1531	13650	1735	15602	1608	14419
P_7	1809	16268	2042	18011	1941	17206
P_8	2154	19013	2366	20666	2251	19855

P_1 : sowing to germination, P_2 : Complete emergence,
 P_4 : Vegetative stage P_5 : Flowering stage
 P_7 : Pod initiation to pod formation

P_3 : Seedling stage
 P_6 : Pegging
 P_8 : Physiological maturity

Table.2 Effect of different treatments on biological yield, pod yield and haulm yield of groundnut

Treatments	Biological yield Kg/ha	Pod yield Kg/ha	Haulm yield Kg/ha
Land configuration			
L₁ Ridges & Furrow	4062	1638	2320
L₂ Broad Bed Furrow	4542	1872	2670
L₃ Sara	3978	1562	2275
L₄ Flat bed	3790	1480	2203
Varieties			
V₁ TAG-24	4631	1974	2657
V₂ SB-XI	3965	1582	2328
V₃ LGN-1	4295	1778	2400

Table.3 Phenophases wise weather parameters data of Variety TAG-24

Phenological Stages	Weather parameters								
	Rainfall	Rainy days	T max	T min	T mean	BSS	WV	GDD	HTU
P₁	19.8	3	30.9	15.3	23.1	9	4.7	52.4	467.58
P₂	7.2	2	28.4	15.1	21.7	7.1	8	99.4	803.82
P₃	66.5	4	35.5	18	25.8	8.5	4.6	383.4	3250.6
P₄	0.5	0	38.6	19.7	29.1	9.4	3.6	843.3	7555.09
P₅	6.7	2	39.8	22.6	31.2	9	4.7	1161.7	10417.65
P₆	10.8	2	38.3	22.7	30.5	8.7	5.4	1531.4	13649.97
P₇	14.5	2	42.2	24	33.1	9.5	5.7	1808.9	16268.35
P₈	27	5	40.3	25.8	33	7.9	7.1	2154.4	19013.4

Table.4 Phenophases-wise weather parameters of Groundnut Variety LGN-1

Pheno phases	Weather Parameters								
	Rainfall	Rainy day	Tmax	Tmin	Tmean	BSS	WV	GDD	HTU
P₁	19.8	3	30.6	15	22.8	9.1	5.1	64.3	584.99
P₂	7.2	3	27.7	16	21.8	6.2	8.6	111.7	882.1
P₃	66.5	3	35	18.5	26.8	8.7	4.1	497.7	4289.27
P₄	4.2	1	38.7	20	29.3	9.3	4	913.3	8176.42
P₅	8.6	2	40	22.5	31.3	9.4	4.5	1254.2	11375.23
P₆	15.2	2	38.8	22.8	30.8	8.5	5.7	1608.1	14418.7
P₇	18.5	4	42.2	25.3	33.8	8.4	6.2	1940.9	17206.27
P₈	37.5	4	38.1	26.3	32.2	8.2	7.6	2251.4	19855.02
Total	177.5	22							
Mean			36.38	20.8	28.6	8.4	5.7		

Table.5 Phenophases wise weather parameters data of groundnut Variety SB-XI

Pheno phases	Weather Parameters								
	Rainfall	Rainy day	Tmax	Tmin	Tmean	BSS	WV	GDD	HTU
P ₁	22.8	4	30.5	15.3	22.9	8.7	5.8	77.3	670.8
P ₂	10.2	3	27.4	16.4	21.9	6.4	8	125.1	981.3
P ₃	60.5	2	35.7	18.5	27.1	8.9	3.9	570.8	4992.2
P ₄	5.2	1	38.6	20.9	29.7	9.2	4.2	1005	8820.2
P ₅	9.6	2	39.9	22.3	31.1	9.7	4.9	1384.8	12462.8
P ₆	14.2	2	40.1	23.7	31.9	8.8	5.6	1735.4	15601.6
P ₇	18.5	4	41.2	25.9	33.6	7.7	6.6	2042.2	18010.9
P ₈	38	3	37.2	25.7	31.7	8.1	9.1	2365.6	20665.9
Total	179	21							
Mean			36.33	21.1	28.9	8.4	6.1		

Phenophases wise Graphs of groundnut varieties
Fig.1 Variety TAG-24

Fig.2 Variety LGN-1

Fig.3 Variety SB-XI

Maximum HTU requirement was observed in P₇ and P₈ (pod initiation to harvest) and the minimum was recorded in P₁ to P₂ (sowing to complete emergence). Maximum HTU required by SB-11 then by LGN-1 and less by TAG-24. This was due to the duration, temperature as well as bright sunshine hours available during the period. The sowing to germination required the lowest heliothermal unit as the duration of this phenophase was minimum. During bud emergence to flower emergence, the HTU requirement was minimum. Among the three varieties, the total HTU requirement was highest in case of SB-XI followed by LGN-1 and less in TAG-24.

The data on yield attributing characters were presented in table 2. The data revealed that biological yield, pod yield and haulm yield was significantly influenced by different land configurations.

The land configuration Broad bed furrow recorded highest yield (1872 Kg/ha) and it was comparable with land configuration Ridges and furrow (1638 Kg/ha) and significantly superior over sara (1562 Kg/ha) and flat bed (1480 Kg/ha).

The data on yield attributing characters were presented in table 2. The data revealed that biological yield, pod yield and haulm yield was significantly influenced by different varieties. The groundnut variety TAG-24 recorded highest and it was comparable with variety LGN-1 and significantly superior over SB-XI.

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How to cite this article:

Khade, S. S., B. V. Asewar, B. R. Bobade and Lalita Verma. 2021. Effect of Heat Units on Growth and Yield of Groundnut Varieties under Different Planting Methods in Summer Season. *Int.J.Curr.Microbiol.App.Sci*. 10(02): 1271-1277.
doi: <https://doi.org/10.20546/ijcmas.2021.1002.150>