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DETERMINATION OF POD MATURITY AND PREDICTION OF PHENOLOGICAL EVENTS IN GROUNDNUT BY USING DEGREE DAY INDICES

K.V.S. Sudheer[1], V. Radha Krishna Murthy, S.B.S. Narasimha Rao and M. Vijaya Sai Reddy[2]

College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad-500 030 (A.P.)

[1]KVK, Kalyandurg, Agricultural Research Station, DCMS Buildings, Kamala Nagar, Anantapur (A.P.)

[2]Agricultural Research Station, DCMS Buildings, Kamala Nagar, Anantapur (A.P.)

ABSTRACT

A field experiment to study the influence of sowing date and row spacing on yield of groundnut crop and to determine the use of heat unit concept expressed in degree days as an indicator of pod maturity was carried out in kharif, 2006 at College Farm, College of Agriculture, Rajendranagar, Hyderabad. The results revealed that the total degree day accumulation recorded a steep reduction with extended date of sowing from 30 July until 4 September. Groundnut crop sown early on 30 July produced maximum pod yield with highest heat use efficiency. The heat use efficiency with respect to haulm yield reduced with early sowing. Irrespective of sowing date, groundnut crop sown at inter row spacing of 30 cm has recorded highest heat use efficiency with respect to pod and haulm yield. The correlation studies revealed that GDD accumulated during different phenophases was positively correlated to the pod yield except at 50 per cent flowering. Correlation between AGDD and haulm yield was significant only at pod development stage. It is concluded that heat units expressed in degree days can be used as an indicator of pod maturity for groundnut crop to maximize the production as it enables to predict optimum harvest date and phenology of the groundnut crop.

Key words: *Groundnut, Sowing date, GDD, HTU, HUE.*

Groundnut is one of the major oil seed crops grown in India. Groundnut kernels are rich nutritional source of niacin, falacin, riboflavin, thiamine, tocopherol, calcium, phosphorus, potassium, magnesium, zinc and iron. Determination of the groundnut harvest is intricate because of its indeterminate growth habit. The colour of pod shell is often used as an indicator of pod maturation. But the concept of heat units, usually expressed in growing degree-days helps to predict maturity of groundnut more precisely than the colour of the pod shell. Heat unit accumulation, often expressed in growing-degree days, has been used to predict maturity, monitor crop progress, and predict phenology of peanut and other agronomic crops (1). (2) used pre determined Cumulative Thermal Time concept in their studies to evolve short duration varieties and reported that the Cumulative Thermal Time procedure could prove useful in peanut breeding to select for earliness.

MATERIALS AND METHODS

A field experiment to study the influence of sowing date and row spacing on yield of groundnut crop and to determine the use of heat units concept expressed in degree days as an indicator of pod maturity in Southern Telangana Zone was carried out in kharif season during 2006 at College Farm, College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad (170 19' N, 780 23'E and 542.3 m above mean sea level). The experiment was laid in split plot design with three replications. The main plot treatments comprised of four dates of sowing viz. 30.07.2006, 10.08.2006, 20.08.2006 and 4.09.2006. The sub plot treatments consisted of three plant spacings viz. 22.5 x 10, 30 x 10 and 45 x 10 cm. Vemana variety was tested for the studies. The data on mean weather parameters recorded during the crop growth period of groundnut sown on different dates are presented in Table-1. Growing Degree Days (GDD) or heat units was calculated by using (3) equation.

$$GDD\ (\ Cd) = \frac{(T_{max} + T_{min})}{2} - Tb$$

Where,

Tmax is the daily maximum air temperature,

Tmin is the daily minimum air temperature and

Tb is the base temperature.

Base temperature of groundnut has been taken as 100C as given by (4).

Photo Thermal Units (PTU) was calculated by using the equation given by (5).

$$PTU = GDD \times N$$

Where,

GDD = Growing degree days (0Cd)

N = Maximum possible sunshine hours

Heat Use Efficiency (HUE): It was worked out for both pod yield and haulm yield by using formula

HUE (kg / ha ^{1} / Cd)

$$\frac{\text{Pod yield (or) haulm yield per hectare}}{\text{GDD}}$$

Helio Thermal Units (HTU) is the product of GDD and actual sunshine hours for that day. Heat Use Efficiency (HUE) was worked out for both pod yield and haulm yield.

RESULTS AND DISCUSSION

Phenophases

The seedling emergence of groundnut occurred in 6 to 7 days irrespective of the time of sowing (Table 2). The crop sown very late on 4 September had an extended duration of 30, 40 and 48 days respectively to attain 50 per cent flowering, pegging and pod initiation stages compared to the crop sown earlier on other dates. The crop sown early on 30 July attained the physiological maturity in 106 days. Subsequent delay in sowing from 10 August to 4 September reduced the duration to 103, 99 and 97 days respectively due to exposure of crop to shortened period of pod development (6) reported that the late sown crop had shorter period for production of pods and its growth.

Accumulation of Growing Degree Days (AGDD)

Maximum GDD accumulation of 138.7°Cd was recorded during the seedling emergence of groundnut sown on 10 August (Table-3). The crop sown very late on 4 September accumulated maximum of 388 degree days for 50% flowering stage. Larger GDD accumulation of 184.10Cd, 163.5°Cd and 934.7°Cd respectively during the pegging, pod initiation and pod development stages was recorded by the crop sown on 30 July. The total GDD accumulation reduced to a minimum of 1467.8 degree days when the sowing was delayed to 4 September. It has been reported that as the sowing in groundnut was delayed, the thermal time requirement of different phenophases got reduced at Anantapur and Ludhiana (7). Hence, our results are in conformity with these studies.

Maximum cumulative growing degree day accumulation was recorded until pod initiation stage of the crop sown very late on 4 September (Table-4). The trend was changed during pod development stage and the crop sown early on 30 July accumulated maximum cumulative growing degree days (17120Cd) to attain maturity. The varieties TMV-2 and Robut 33-1 grown in semi-arid Anantapur region of India required 1732°Cd and 1839°Cd of growing degree days, respectively (8). Hence, our studies are in accordance with these findings.

Helio Thermal Units (HTU)

Accumulation of HTU during different phenophases of groundnut was remarkably influenced by the adopted sowing time. Groundnut sown very late on 4 September registered maximum accumulation of 979.90Chr HTU during emergence (Table 3). But HTU accumulation during pod development stage was reduced in sharp to 4419. 10Chr due to this sowing. Larger HTU accumulation of 2452.70Chr from

Table-1. Mean weather parameters recorded during crop growth period of groundnut sown on different dates.

Date		Rainfall (mm)	Temperature (°C)		RH (%)		Sun shine (hrs)	Wind speed (km/hr)	Evaporation (mm)
Sowing	harvest		T_{max}	T_{min}	I	II			
30.07.2006	13.11.2006	421.9	30.0	22.0	90.1	62.5	5.3	7.2	4.7
10.08.2006	21.11.2006	302.6	30.2	21.5	89.9	60.2	5.9	5.9	4.7
20.08.2006	27.11.2006	285.6	30.1	21.2	89.6	58.3	6.0	4.9	4.7
04.09.2006	10.12.2006	208.9	29.9	20.0	90.3	55.3	6.4	4.3	4.5

Table-2 : Influence of sowing date on phenological events of groundnut crop.

Phenological event	Sowing date			
	30.07.06	10.08.06	20.08.06	04.09.06
	Days after sowing			
Emergence	6	7	6	6
50% flowering	26	25	25	30
Pegging	36	35	35	40
Pod initiation	45	44	43	48
Pod maturity	106	103	99	97

emergence to 50 per cent flowering was recorded when sowing was delayed to 20 August. The period from 50 per cent flowering to pegging was exposed to maximum HTU accumulation of 14230Chr when the crop was sown on 10 August. The crop sown on 10 August registered maximum HTU accumulation of 98520Chr for completion of all phenophases from sowing until its physiological maturity.

Photo Thermal Units (PTU)

Maximum PTU accumulation of 1761.50Chr was recorded during the seedling emergence of groundnut sown on 10 August (Table 3). The crop was exposed to a maximum of 4694.80Chr PTU accumulation for 50% flowering when sowing was delayed to 4 September. Larger PTU accumulation of 22460Chr, 1994.70Chr and 109360Chr respectively during pegging, pod initiation and pod development stages was recorded by the crop sown on 30 July. The PTU accumulation for entire crop growth period recorded a steep reduction with extended date of sowing from 30 July until 4 September.

Heat Use Efficiency (HUE)

Groundnut crop sown early on 30 July produced maximum pod yield of 831 kg per hectare by recording highest (0.49) heat use efficiency (Table 5). Subsequent delay in sowing from 10 August to 4 September reduced the heat use efficiency to 0.43, 0.16 and 0.13 respectively. The groundnut crop grown at an inter row spacing of 30 cm has recorded highest heat use efficiency (0.33) with respect to pod yield. The crop sown later on 20 August produced haulm yield of 1863 kg per hectare with highest heat use efficiency (1.19). The heat use efficiency with respect to haulm yield reduced with early sowing of crop on 30 July and 10 August to 1.16 and 1.08 respectively. The groundnut crop grown at an inter row spacing of 30 cm has recorded maximum heat use efficiency (1.20) with respect to haulm yield.

The groundnut pod yield was reduced when sowing was delayed to 20 August and 4 September due to shortened period of pod development stage as the crop was exposed to cooler night temperatures (less than 20°C) and moisture stress. Exposure of late sown groundnut crop to cooler night temperatures (less than 20°C) and lack of further rainfall during reproductive and maturity stages of the crop at Ludhiana, Anand and Anantapur gave lowest pod yields (7).

Table-3 : Influence of sowing date on accumulation of heat units (GDD, HTU and PTU) of groundnut crop during different phenophases.

Phenophase	30 July 2006 (D1)			10 Aug 2006 (D2)			20 Aug 2006 (D3)			04 Sep 2006 (D4)		
	GDD	HTU	PTU	GDD	HTU	PTU	GDD	HTU	PTU	GDD	HTU	PTU
Sowing-Emergence	107.8	217.6	1369.1	138.7	690.7	1761.5	105.4	713.1	1560.8	124.6	979.9	1520.1
Emerg. 50% flowering	322.2	1611.6	4091.9	306.3	1916.7	3859.4	348.9	2452.7	4043.1	388	1628.3	4694.8
50% Flowering pegging	184.1	1090.0	2246.0	181.6	1423.0	2215.5	156.4	395.5	1909.3	165.5	1294.0	1936.3
Pegging-pod initiation	163.5	1386.9	1994.7	140.0	347.7	1708.0	126.2	626.6	1539.6	128.6	1025.9	1504.6
Pod initiation-pod maturity	934.7	5008.6	10936.0	880.4	5474.0	10388.7	824.6	5362.6	9482.9	661.1	4419.1	7470.4
Total	1712.3	9314.7	20637.7	1647.0	9852.0	19933.1	1561.5	9550.6	18535.7	1467.8	9347.2	17126.3

Table-4 : Influence of sowing date on cumulative heat unit requirement (GDD, HTU and PTU) of groundnut crop during different phenophases.

Phenophase	30 July 2006 (D1)			10 Aug 2006 (D2)			20 Aug 2006 (D3)			04 Sep 2006 (D4)		
	GDD	HTU	PTU	GDD	HTU	PTU	GDD	HTU	PTU	GDD	HTU	PTU
Emergence	107.8	217.6	1369.1	138.7	690.7	1761.5	105.4	713.1	1560.8	124.6	979.9	1520.1
50%flowering	430.0	1829.2	5461.0	445.0	2607.4	5620.9	454.3	3165.8	5603.9	512.6	2608.2	6214.9
Pegging	614.1	2919.2	7707.0	626.6	4030.4	7836.4	610.7	3561.3	7513.2	678.1	3902.2	8151.2
Pod initiation	777.6	4306.1	9701.7	766.6	4378.1	9544.4	736.9	4187.9	9052.8	806.7	4928.1	9655.8
Physiological maturity	1712.3	9314.7	20637.7	1647.0	9852.0	19933.1	1561.5	9550.6	18535.7	1467.8	9347.2	17126.3

Table-5: Influence of sowing date and row spacing on yield and heat use efficiency of groundnut.

Treatment	Pod yield (kg/ha)	Haulm yield (kg/ha)	Accumulated degree days	Pod yield with GDD	Haulm yield with GDD
Sowing Date					
30 July	831	1980	1712.3	0.49	1.16
10 August	707	1779	1647.0	0.43	1.08
20 August	257	1863	1561.5	0.16	1.19
4 September	185	1599	1467.8	0.13	1.09
SE ±	21	20	—	0.01	0.01
CD (0.05)	52	50	—	0.03	0.03
Row spacing (cm)					
22.5	481	1809	1597.2	0.29	1.13
30	550	1915	1597.2	0.33	1.20
45	454	1693	1597.2	0.28	1.06
SE ±	14	43	—	0.01	0.03
CD (0.05)	30	92	—	0.02	0.06
Sowing date x row spacing					
SE ±	28	87	—	0.02	0.12

Table-6: Correlation coefficients between pod, haulm yield and AGDD during different phenophases of groundnut crop.

Phenophase	Correlation coefficient between pod yield and AGDD	Correlation coefficient between haulm yield and AGDD
Emergence	0.13	-0.43
50% flowering	-0.86*	-0.50
Pegging	0.91*	0.27
Pod initiation	0.88*	0.51
Pod maturity	0.85*	0.67*
Total	0.94*	0.63*

*Significant at 5% level.

Correlation studies between pod and haulm yield and accumulated growing degree days from table 6 revealed that the correlation between AGDD and pod yield was significant from the stage of 50 per cent flowering to physiological maturity of groundnut. GDD accumulated during different phenophases was positively correlated to the pod yield except at 50 per cent flowering. The data also revealed that correlation between AGDD and haulm yield was significant during pod development stage. However, the correlation between pod and haulm yield and total degree day accumulation for entire crop growth period was found significant and positive.

From the above studies, it is concluded that heat units expressed in degree days can be used as an indicator of pod maturity for groundnut crop to maximize the production as it enables to predict optimum harvest date and phenology of the groundnut crop.

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