

A Web based Photothermic Indexing Calculator for Rice Genotypes

Plants require a certain amount of heat to develop from one point in their life cycles to another. This measure of accumulated heat is known as physiological time. Physiological time is often expressed and approximated in units called degree days (D). The development rate over time is expressed in daily heat units/degree days($^{\circ}\text{C d}$). All plants tend to respond to the seasonal and daily variation in the duration of night and day time periods. Plant responses to this variation were attributed to the variation in the day time duration(Photoperiod) rather than to its complementary part of dark time duration (Nyctoperiod). Rice has been classified as a quantitative short day plant. In other words, it is a long night requiring plant. Hence nyctoperiods are also considered.

Heat Units/Degree Days($^{\circ}\text{C d}$) : The growth and development of both plants and insects is strongly dependent on temperature. Below the base temperature (T_d) and above the maximum temperature (T_m) the rate of development is zero. Three cardinal temperatures base temperature, optimum temperature(T_o) and maximum temperatures are identified to compute the heat units. The development rate over time is expressed in daily heat units/degree days($^{\circ}\text{C d}$). Daily heat units were calculated using the following formula

$$HU = \sum_{h=1}^{24} (HUH)$$

where h is time of the day. Hourly increments in Heat Units (HUH) are calculated if $T_d \leq T_b$ and $T_d \geq T_h$ then $HUH=0$

if $T_b < T_d$ and $T_d \leq T_o$ then $HUH=(T_d-T_b)/24$

if $T_o < T_d$ and $T_d < T_h$ then

$$HUH = [T_{opt} - (T_d - T_{opt}) \times (T_{opt} - T_{base}) / (T_{high} - T_{opt})] / 24$$

Daylength (Photoperiod in hours): These calculations involve some empirical relationships that calculate the day length and integral of the sine of the solar angle from the day number and latitude. Nyctoperiod is calculated by subtracting the photoperiod from 24.(total no. of hours /day).

Manual process of computing day wise values is tedious and time consuming. Hence, Photothermic Indexing (PTI) software has been developed to compute day wise heat units, photoperiod and nyctoperiod and genotype wise cumulative photoperiod and nyctoperiod at different stages of Rice crop.

PTI software has 3 tabs for Home, Compute PTI and Contact details. Home page has login form with brief introduction about computation of PTI. User registration is mandatory for using the computation facility of PTI. Compute PTI tab has 3 menu items such as Heat Units/Degree Days, Day Length/Photoperiod and Nyctoperiod, Experimental data- Photoperiod and Nyctoperiod.

PHOTO THERMIC INDEXING
 [COMPUTING PHOTO PERIOD AND NYCTO PERIOD]

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Please enter your username and password. Register: [You can create an account](#)

ACCOUNT/SESSION

Username:

Password:

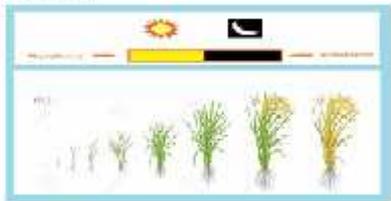
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Plants require a certain amount of heat to develop from one point in their life cycle to another. This measure of accumulated heat is known as physiological time. Physiological time is often expressed and accumulated in units called degree days (DD). Heat units are equal to the amount and daily variation in the 24-hour night and day heat (in °C). Heat exposure by the system was obtained by the variation in the day (total day/night period) after time 0. The exposure period of time duration (development). Also has been classified as a quantitative time day plant. In other words, it is a long night resulting plant (long photoperiod) are also considered.



Heat Units/Degree Days (HDD)

The growth and development of field grown plants is strongly dependent on the mean air temperature (T_a) over a given time period. In addition, long-term mean (T_a) the rate of development is also. These related temperature and development (growth temperature) and (night, or photoperiod) are identified to compute the heat units. The cumulative heat unit (HCU) is increased in daily heat units, degree days (DD).

Heat units were calculated using the following formula:

$$HCU = \sum_{i=1}^n T_{a,i}$$

where: $T_{a,i}$ = the daily mean air temperature (HDD) over a period
 $T_{a,i} = (T_{max} + T_{min}) / 2$
 $T_{max} = T_a + (T_{app} - T_a) / 2$
 $T_{min} = T_a - (T_{app} - T_a) / 2$
 $T_{app} = (T_{day} + T_{night}) / 2$
 $HCU = (T_{app} - T_{base}) \times (T_{app} - T_{base}) / 2$

Default (T_{base}) is used:

These calculations involve some empirical relationships that calculate the day length and integral of the sine of the cosine angle from the day number etc. latitude (longitude) is calculated by subtracting the geocentric from 21-degree, etc. of hour (day).

Heat Units/Degree days

This menu prompts for location, start date and end date and minimum and maximum temperatures for computing degree days. In addition to this, there is “Copy from Excel check box” to copy temperatures from excel to the interface and by clicking the “Click here to copy data to the grid” the data will be copied to the grid. By using ‘Calculate Result’ Heat degrees will be computed and displayed in the grid. This data can be copied easily to Excel or Word.

(COMPUTING PHOTO PERIOD AND NYCTO PERIOD)

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HEAT UNITS / DEGREE DAYS

Location:
 add your Location and Latitude

Start Date:

End Date:

T base:

T opt:

T High:

Cardinal Temperatures for Rice (Gao et al 1992)

Base temperature(Tbase, 0C) = 8

Optimum Temperature(Topt , 0C) = 30

Maximum Temperature(Thigh , 0C)= 42

enter temperatures in degree celsius

Copy from Here!

S.No.	Date	TMIN	TMAX
1	12-6-2019	19	28
2	13-6-2019	24	30
3	14-6-2019	20	32
4	15-6-2019	18	25

[Source & Reference](#)

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HEAT UNITS / DEGREE DAYS

Location:
 add your Location and Latitude

Start Date:

End Date:

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T opt:

T High:

Cardinal Temperatures for Rice (Gao et al 1992)

Base temperature(Tbase, 0C) = 8

Optimum Temperature(Topt , 0C) = 30

Maximum Temperature(Thigh , 0C)= 42

S.No	Date	Tmin	Tmax	tot hu	cum hu
1	12-6-2019	19	28	16.0	16.0
2	13-6-2019	24	30	10	24.5
3	14-6-2019	20	32	15.00	59.00
4	15-6-2019	18	25	15.5	89.55

[Here all Temperature's are in degree celsius (0C)]

[Source & Reference](#)

Daylength (Photoperiod in hours)

This menu prompts for location, start date and end date and computes photoperiod and nyctoperiod for the input dates. By using the submit button Julian date, photoperiod and nyctoperiod will be calculated and displayed in the grid. This data can be copied easily to Excel or Word.

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DECLINATION OF SUN SHINE

Location:

Add your Location and Latitude

Start Date:

End Date:



S.No	Selected Date	Julian Day value	Cumulative DD	Cumulative Nycto Period
1	07-6-2019	78	11,9515	10,046
2	08-6-2019	79	11,916	11,965
3	09-6-2019	80	11,8806	13,884
4	10-6-2019	81	11,8456	15,803
5	11-6-2019	82	11,8106	17,722
6	12-6-2019	83	11,7756	19,641
7	13-6-2019	84	11,7406	21,560
8	14-6-2019	85	11,7056	23,479
9	15-6-2019	86	11,6706	25,398
10	16-6-2019	87	11,6356	27,317
11	17-6-2019	88	11,6006	29,236

[Source & Details](#)

Experimental data- Photoperiod and Nyctoperiod

Experimental data interface has two forms; One form prompts for sowing date, sowings, number of replications and varieties. There are two check boxes for opting the crop growing stages like Panicle Initiation and Flowering. Second form generates grid for the above sowings, replications and varieties. The data can be copied from excel using 'Copy from Excel' check box and by clicking the "Click here to copy data to the grid" the data will be copied to the grid. The by using "Add PTI details", the data will added to the PTI database and computes grid wise photoperiod and nyctoperiod at different stages of rice crop. The values will be displayed in the grid. The data generated by this software can be easily copied to excel and use for further nalysis with other data sets.

PTI USING EXPERIMENTAL DATA

Location:

add your Location and Latitude

Sowing stage Level:

Sowing Date for Level:

Number of Replications:

Number of Varieties:

Stage: days PI panicle initiation days FI Towing in



09	78	120
55	80	125
75	77	126
03	83	120

[click here to copy data to the form below](#)

Location	PTI Year	Sowing Level	Replication	Variety	Days_PI	Days_FL	Days_MAT
IRR	2020	1	1	1	<input type="text" value="31"/>	<input type="text" value="91"/>	<input type="text" value="120"/>
IRR	2020	1	1	2	<input type="text" value="34"/>	<input type="text" value="80"/>	<input type="text" value="124"/>
IRR	2020	1	2	1	<input type="text" value="24"/>	<input type="text" value="77"/>	<input type="text" value="124"/>
IRR	2020	1	2	2	<input type="text" value="23"/>	<input type="text" value="85"/>	<input type="text" value="123"/>

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PTI - EXPERIMENTAL DATA

S.No	Level	Replication	Variety	DD_PI	Nycto_Period_PI	DD_FL	Nycto_Period_FL	DD_MAT	Nycto_Period_MAT
1	1	1	1	155.8	252.1	676.24	801.78	2226.17	1757.87
2	1	2	1	420.42	450.58	1006.07	1029.96	2510.5	1409.5
3	1	1	2	604.75	255.24	902.36	825.84	1620.61	1442.99
4	1	2	2	250.01	271.99	811.59	748.41	1564.78	1387.22

This software was evaluated with five years data of photothermic indexing experiment conducted under All India Coordinated Rice Improvement Programme (AICRIP). This software is easily understandable and user friendly. As this program uses solar declination and latitude to compute photoperiod and nyctoperiod, the software can be used for other crops also. This can be easily customized any other experimental designs.