수도의 발육 단계 추정을 위한 광-온도 모형

수원 측후소 : 이변우, 김병찬
서울대농대 : 이은웅

Photo-Thermal Model for the Prediction of Rice Developmental Stage

Suwon Weather Forcasting Office : Byun-Woo Lee
Byung-Chan Kim
Coll. of Agric., SNU : Eun-Woong Lee

ABSTRACT

A photo-thermal model to predict the developmental stage of rice was formulated and tested using data from field planting date experiments with 15 rice cultivars. This model incorporates mean daily temperature, dark period and sunshine duration as predictor variables.

The model formula for daily developmental advance is

$$dD/dt = K\ (K_T.Teq + a)\ \{Kp\ (P + r.DS) + b\}$$

where Teq, P and DS refer to equivalent temperature $\{Teq = 2T\ [(T-Tbase)^2\ (Topt-Tbase)^2 - (T-Tbase)^4]\ /(Topt-Tbase)^4$; T, daily mean temperature $\}$, dark length and sunshine duration, respectively and others are developmental rate constants of predictor variables and intercepts. In determining the constants, multiple linear regression was used between predictor variables and daily developmental advance, which was postulated as the inverse of growth duration from transplanting to heading.

The growing degree day models were tested for the comparison using the same field data as well. The predictions from the photo-thermal model were found to be superior to the predictions made from growing degree day models. The accumulated photo-thermal units from transplanting to heading showed less than one percent of coefficient of variation with a few exceptional varieties.

Table 1. Optimum and base temperature for development, and regression coefficients of photo-thermal model.

Cultivar	Temp.		Regression coefficient of						Coefficient of variation(%)
	Opt	Base	Const.	Teq.	Teq.DS	DL	DS	Teq.DL	
Chiak	25	17	18.78	-2.00	1.34×10^{-3}	-2.01	0.208	0.212	4.28
Sobaek	25	13	9.63	-0.73	-1.07×10^{-2}	-1.26	0.345	0.094	1.05
Odae	26	2	16.50	-0.63	-1.50×10^{-2}	-2.05	0.365	0.088	0.26
Bokkwang	27	1	-23.69	1.13	-1.93×10^{-2}	1.94	0.487	-0.088	0.31
Kwanak	30	2	-88.46	4.21	-1.89×10^{-2}	8.63	0.479	-0.406	1.15
Taebaeg	30	3	-102.98	5.12	-2.06×10^{-2}	10.14	0.549	-0.502	3.23
Sangpung	30	19	-8.59	0.78	-2.73×10^{-2}	0.64	0.366	-0.048	0.60
Kiho	30	18	-12.97	1.14	-1.09×10^{-2}	1.16	0.269	-0.101	0.11
Mansuk	28	4	-6.59	0.47	-4.21×10^{-2}	-0.058	0.803	-0.002	0.18
Wonpung	25	20	10.13	0.13	-7.37×10^{-3}	-0.816	-0.127	-0.020	0.30
Pungsan	26	5	-38.21	1.94	-1.11×10^{-2}	3.628	0.330	-0.182	0.87
Sujeong	28	0	-73.75	3.39	-1.03×10^{-2}	7.312	0.300	-0.334	2.45
Jinju	29	12	-19.52	1.16	-1.68×10^{-2}	1.625	0.419	-0.096	0.10
Nakdong	29	8	-57.17	2.80	-1.76×10^{-2}	5.340	0.563	-0.263	0.88
Seomjin	29	2	129.99	-5.56	-1.87×10^{-2}	-13.78	0.268	0.603	2.49

Table 2. Coefficients of variation of accumulated equivalence temperature, growing degree day (GDD), and photo-thermal unit from transplanting to heading.

Cultivar	Acc. equiv. temp.			GDD-1 a)		GDD-2 b)			P.T.U.
	Topt	Tbas	C.V.	Tbas	C.V.	Topt	Tbas	C.V.	C.V.
Chiak	30	4	9.82	13	9.84	28	14	9.78	4.28
Sobaek	28	0	8.62	11	8.63	30	11	8.63	1.06
Odae	28	0	4.91	10	4.91	30	10	4.91	0.26
Bokkwang	30	2	5.42	12	5.44	29	12	5.50	0.31
Kwanak	30	7	4.81	15	4.80	30	15	4.80	1.15
Taebaeg	26	5	5.03	10	5.10	30	10	5.10	3.23
Sangpung	30	6	7.07	14	7.20	30	14	7.20	0.60
Kiho	30	11	5.80	16	6.02	30	16	6.02	0.11
Mansuk	29	0	7.00	11	7.01	30	11	7.01	0.18
Wonpung	30	5	5.63	14	5.65	30	14	5.65	0.87
Pungsan	26	2	3.99	9	4.02	30	9	4.02	2.45
Sujeong	29	4	4.77	13	4.77	30	13	4.77	0.10
Jinju	29	13	6.80	17	6.75	30	17	6.75	0.88
Seomjin	30	12	5.59	17	5.86	28	18	5.84	2.49

a) GDD-1 : Σ(Mean Temp.-Tbas), if mean temp. Tbas, GDD=0.0

b) GDD-2 : The same as GDD-1, but that GDD= Topt-(mean temp -Topt), if mean temp. Topt.