PREDICTING GRAIN SORGHUM PHYSIOLOGICAL MATURITY

by

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INTRODUCTION

Plant growth models are useful in simulating effects of environmental, genetic, and management factors on plant growth and development. They also aid in identifying discontinuity in knowledge and data about plant growth and development. The grain sorghum (Sorghum bicolor (L.) Moench.) growth model developed by Arkin, Vanderlip, and Ritchie (1976) underestimated developmental time to physiological maturity (Vanderlip and Arkin, 1977). Physiological maturity was consistently modeled too early, because their model appeared to be insensitive to some environmental condition which occured during a portion of the growing season. In their model, plant development was related to the developmental stages of grain sorghum proposed by Vanderlip and Reeves (1972). Vanderlip (1972) has shown that grain sorghum plant parts accumulate dry matter in relation to stage of development. He indicated that three stages are of particular importance in determining what plant parts are actively accumulating dry matter. The stages are: growing point differentiation, half-bloom, and physiological maturity.

Their model simulates leaf development, to which growing point differentiation and half-bloom can be related (Eastin et al., 1971; Pauli, Stickler, and Lawless, 1964; Vanderlip and Reeves, 1972). However, the factors that determine physiological maturity are not well understood. Pauli, Stickler, and Lawless (1964) showed that for several varieties planted at Manhattan, Kansas and Colby, Kansas, over a range of dates, the relative time required for grain filling was approximately onethird the time from emergence to physiological maturity. Eastin et al. (1971) showed that grain sorghum hybrids have a relatively longer grain filling period than parental lines. However, Quinby (1972) reported that hybrid vigor did not appear to lengthen the period of grain filling, but that early flowering by hybrids is caused by a shorter period of growth prior to growing point differentiation (floral initiation) and a shorter period of panicle development. Vanderlip and Arkin (1977) defined the number of days from emergence to physiological maturity in their model as 1.6 times the computed days from emergence to half-bloom.

Various systems can be used to determine the development of a crop from time of planting to maturity. In general, the system of determining life-cycle length by the number of days between planting and physiological maturity is not accurate. A crop planted over a diverse geographical area will show a wide range in the number of days to maturity, both within and between seasons. Days to maturity will also vary depending on planting date and variety.

The general influence of temperature and daylength on the development of crops is well known, with temperature largely determining the types of crops which can be grown in a given region (Robertson, 1968, 1973). Greatest success in predicting plant development has been with the use of temperature alone. A number of temperature-unit systems have been used as alternatives to calendar days to measure the length of plant life cycle (Shaw, 1975). Growing-degree units are often used to represent the relation between temperature and rate of growth and development of a plant. Although no simple growing-degree unit system can exactly define the length of a plant life-cycle under a wide range of weather conditions, the variation around the mean value will be less than for a calendar-day system (Brown, 1963; Aspiazu and Shaw, 1972).

Growing-degree units are a simplified approach to a complex relationship. Photoperiod and water relations are examples of other factors often included in a developmental modeling system. Including these, and other factors, however, negates one of the major advantages of a simple temperature-unit system; i.e., the simplicity (Shaw, 1975). Growing-degree units do not generate constant values, which is expected because of the simplicity of the relationship.

Temperature-unit systems have had their greatest success in estimating the date of maturity of certain vegetable crops, chiefly peas and corn (Holmes and Robertson, 1959; Gimore and Rogers, 1958). Clegg et al., (1969, 1970) found no consistancy in the number of temperature-units required for grain sorghum to develop from planting to physiological maturity.

The purpose of this study was to use available field data on grain sorghum development to test various temperature-unit systems for the ability to predict physiological maturity. When a satisfactory equation is developed it will be compared with the equation used by Vanderlip and Arkin (1977), in an attempt to improve the predictive ability of their model.

METHODS

Reaumur (1735) suggested that the sum of the mean daily temperatures from planting to maturity was constant for a particular plant species. His technique is still used almost in its original form by many plant geographers, horticulturalists, and vegetable canning companies. The equation states that a plant requires a summation (K) of daily mean temperature (T_m) from planting (P) to physiological maturity (M), when the base temperature (or threshold of growth) is (b):

$${}_{P}^{M}(T_m - b) = K \qquad (1)$$

where $(T_m - b) = 0$ when $T_m < b$.

Clegg et al. (1969) used this equation with base temperatures of 60°, 65°, and 70°F for grain sorghum. Often the growing-degree unit is calculated with consideration for upper and lower critical limits to the daily maximum and minimum temperatures, respectively. Gilmore and Rogers (1958) suggested it would be more accurate to consider all minimum temperatures below the base temperature as equal to the base temperature. This allows days with minimums below the base to accumulate growing-degree units. Other workers (Madariaga and Knott, 1951) are concerned about the effect of high temperatures on plant development and adjust for this by calculating growing-degree units by setting all maximum temperatures above a critical limit equal to the critical limit.

The National Weather Service method of calculating growing-degree units sets b = 50°F and adjusts for maximum temperatures above 86°F and for minimum temperatures below 50°F. For example, a day with a maximum temperature of 95°F and a minimum of 68°F would result in $((86+68)/2)-50 = 27$ growing-degree units and a day with a maximum temperature of 78°F and a minimum of 41°F would result in $((78+50)/2)-50 = 14$ growing-degree units. This system is the one now in use in the National Weekly Weather and Crop Bulletin.

Shaw (1975) calculated growing-degree units for corn based on the average date of planting. This date varies across a crop region which allows for the adaptation of a growing-degree unit system to the environmental diversity present in the region.

Five years of weather and grain sorghum growth and development data (1965, 1966, 1969, 1970, and 1971) from the hybrid RS-610 at Manhattan, Kansas were selected to determine which growing-degree unit system best estimated physiological maturity. The units were determined and tested by comparing the coefficients of variation ($s/\overline{X}$). The best estimating system was then expanded to include 14 data sets at Manhattan with 5 years weather and developmental data from 4 hybrids.

If the growing-degree unit equation developed by this study is to be of value then it must improve the present predictive ability of the equation based on a ratio of days from emergence to half-bloom, used by Vanderlip and Arkin (1977).

RESULTS

Table 1 presents the field data from which this report was developed. It is the same data set used by Vanderlip and Arkin (1977) to test their predictive model.

The data from 5 years of growth and development studies on the grain sorghum hybrid RS-610 at Manhattan, Kansas were used to select the best growing-degree system to use. Equation (1) was used with a variety of critical limits arbitrarily selected for testing. The base temperature (b) was allowed to vary from 40° to 65°F. The equation was used with 1) no critical limits imposed; 2) the minimum critical limit equal to the base temperature; and 3) with the maximum critical limit allowed to vary from 80° to 100°F. Table 2 shows the results of evaluating the amount of variation in the various systems tested.

A system using b = 50°F and setting maximum and minimum critical limits of 80° and 50°F was the most accurate estimator of physiological maturity with this small data base, having a coefficient of variation of 0.083. Arnold (1975) suggested that for corn, use of a 45:80 combination would improve the corn growing-degree unit system. However, Shaw (1975) accepted the less accurate 50:86 combination which is used by the National Weekly Weather and Crop Bulletin and accepted by the corn-seed industry. Although no system is currently accepted by the grain sorghum seed industry it was decided to use the 50:86 National Weather Service method since no large loss in accuracy is apparent.

In order to easily introduce a new system of determining

Table 1. Field Data Used

Year, location, and hybrid	Date of Planting	Date of Emergence	Date of Half-Bloom	Date of Maturity
1965 Manhattan, Kansas				
RS-610	5-17 (137)*	5-23 (143)	7-26 (207)	8-31 (243)
KS-650	5-17 (137)	5-23 (143)	7-28 (209)	9-5 (248)
KS-701	5-17 (137)	5-23 (143)	8-4 (216)	9-10 (253)
1966 Manhattan, Kansas				
RS-610	6-13 (164)	6-18 (169)	8-12 (224)	9-26 (269)
KS-650	6-13 (164)	6-18 (169)	8-13 (225)	9-26 (269)
KS-701	6-13 (164)	6-18 (169)	8-17 (229)	10-1 (274)
1969 Manhattan, Kansas				
RS-610	6-30 (181)	7-4 (185)	8-27 (239)	9-26 (269)
RS-702	6-30 (181)	7-4 (185)	9-2 (245)	10-14(287)#
1970 Manhattan, Kansas				
RS-610	6-11 (162)	6-15 (166)	8-14 (226)	9-25 (268)
RS-702	6-11 (162)	6-15 (166)	8-23 (235)	10-3 (276)
KS-650	6-18 (169)	6-23 (174)	8-23 (235)	10-4 (277)
RS-702	6-18 (169)	6-23 (174)	9-2 (245)	10-8 (281)
1970 Columbia, Missouri				
E-57	6-9 (160)	6-13 (164)	8-13 (225)	9-17 (260)
RS-702	6-9 (160)	6-13 (164)	8-20 (232)	9-24 (267)
1971 Manhattan, Kansas				
RS-610	6-4 (155)	6-8 (159)	8-14 (226)	9-25 (268)
RS-702	6-4 (155)	6-8 (159)	8-21 (233)	10-9 (282)
KS-650	6-1 (152)	6-5 (156)	8-12 (224)	9-14 (257)
RS-702	6-1 (152)	6-5 (156)	8-16 (228)	9-26 (269)
1971 Columbia, Missouri				
E-57	6-4 (155)	6-8 (159)	8-8 (220)	9-12 (255)
RS-702	6-4 (155)	6-8 (159)	8-15 (227)	9-19 (262)
1971 Lincoln, Nebraska				
RS-626	6-15 (166)	6-19 (170)	8-16 (228)	10-2 (275)
1972 Rocky Ford, Colorado				
Neb-505	5-12 (133)	5-17 (138)	7-15 (197)	8-29 (242)
RS-610	5-12 (133)	5-17 (138)	7-19 (201)	9-6 (250)
1974 College Station, Texas				
RS-610	4-5 (095)	4-12 (102)	6-7 (158)	7-12 (193)

* Julian date
# Freeze date

physiological maturity into the Arkin, Vanderlip, and Ritchie (1976) model it was decided to develop an equation for the number of growing-degree units required for the grain sorghum plant to develop from half-bloom to physiological maturity. This was acceptable because the leaf development routines of the

Table 2. Coefficient of Variation, Growing-degree Units, Planting to Physiological Maturity, RS-610, Manhattan, Kansas 1965, 1966, 1969, 1970, 1971

Minimum and/or Base	65°F	60°F	55°F	50°F	45°F	40°F
Maximum						
No Critical Limits	.147	.123	.101	.097	.095	.094
No Maximum	.126	.112	-	-	-	-
100°F	.122	.110	-	-	-	-
95°F	.115	.106	.097	.094	.092	.092
90°F	-	-	-	.090	.089	-
85°F	-	-	-	.085	-	-
80°F	-	-	-	.083	.083	.084

model accurately predict date of half-bloom (Vanderlip and Arkin, 1977).

The data base was expanded to include 14 sets of developmental data on 4 hybrids over 5 years at Manhattan, Kansas. The hybrids were RS-610, KS-650, KS-701, and RS-702.

By plotting the Julian date of planting versus the number of 50:86 growing-degree units summed from half-bloom to physiological maturity, a least squares equation was calculated to fit the data points (Figure 1.). The data could best be approximated with a linear regression equation:

$$Y = 1221.84 - 2.3X \qquad (r = -.050) \qquad (2)$$

where Y = the number of 50:86 growing-degree units needed from half-bloom to physiological maturity, and X = the Julian date of planting. In some cases of late planting, an early freeze (29°F or less) or a cold period (31°F or less for two days in a row) may kill the plant before enough growing-degree units have accumulated. In these cases physiological maturity is assumed to have occured on the day of the freeze, or the second day of the cold period.

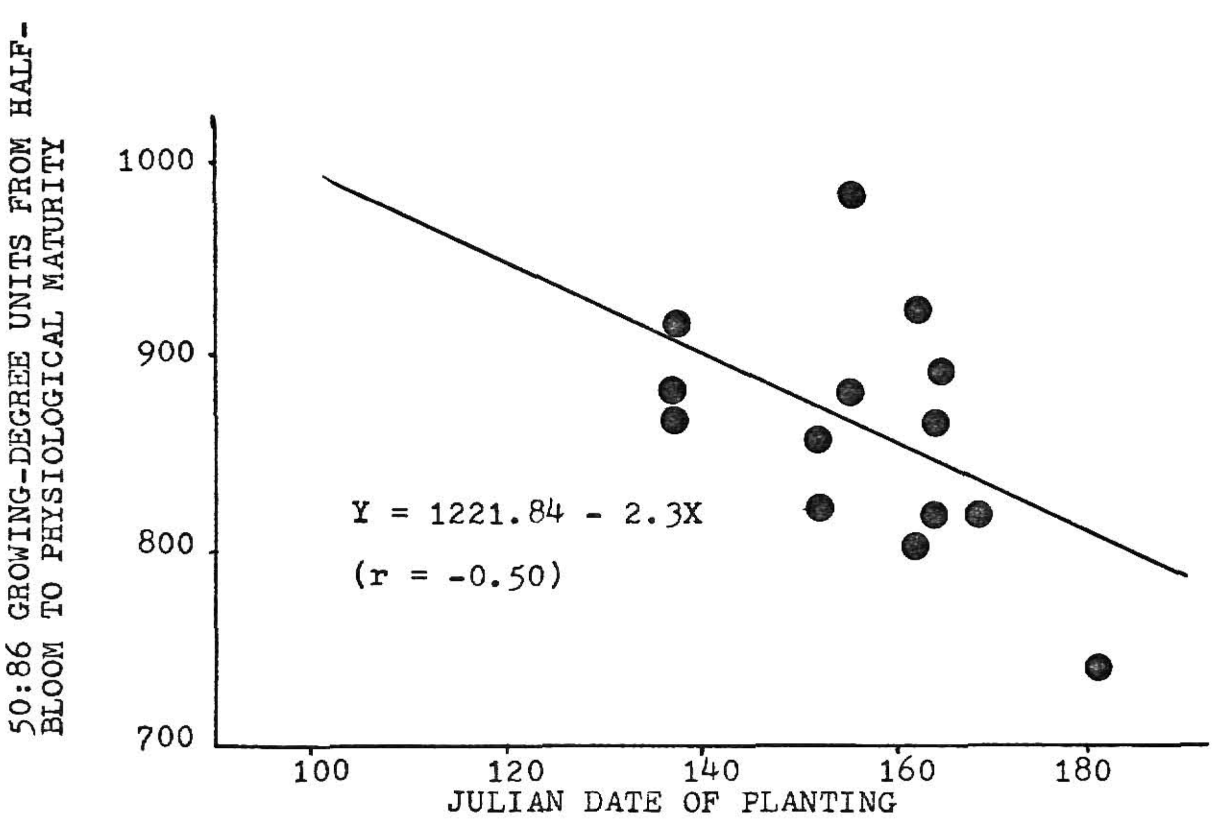

Figure 1. Regression of 50:86 growing-degree units from half-bloom to physiological maturity on planting date.

Table 3 shows these 14 data sets from Manhattan, Kansas and compares them with the predicted date of physiological maturity using the regression equation (2). The regression equation underestimated physiological maturity by an average difference of only -0.36 days. This underestimation was not significantly different from zero when tested using the "Student's" t test, where t = 0.52 ($P > 0.50$). In 13 of the 14 cases the predicted physiological maturity was within 5 days of the actual event.

To test the equation further the data base was expanded to include all 24 data sets (Table 1) used by Vanderlip and Arkin (1977). Environmental and management conditions varied widely among the five locations and seven years gathered in this data

Table 3. Comparison of regression equation and 14 sets of field data from Manhattan, Kansas

Year	Hybrid	Estimated Physiological Maturity Date	Physiological Maturity Error in Days
1965	RS-610	9-2	+2
	KS-650	9-5	0
	KS-701	9-12	+2
1966	RS-610	9-23	-3
	KS-650	9-24	-2
	KS-701	10-3	+2
1969	RS-702	10-14#	0
1970	RS-610	9-20	-5
	RS-702	10-5	+2
	KS-650	10-5	+1
1971	RS-610	9-23	-2
	RS-702	10-1	-8
	KS-650	9-19	+5
	RS-702	9-27	+1

freeze date

n.s. not significantly different from zero

$\bar{d}$ = -0.36
$s\bar{d}$ = 0.69
t = -052 n.s.

set. Seven hybrids, both irrigated and dryland production, were represented. Table 4 shows the results of using the regression equation (2) to predict grain sorghum physiological maturity using this wide range of field data obtained from the grain sorghum production area of the United States.

The regression equation (2), based on the Julian date of planting resulted in an average overestimation of the physiological maturity date by 0.96 days. This overestimation was not significantly different from zero when tested using the "Student's" t test, where $t = 1.07$ ($P > 0.30$). In 18 of the 24 cases, the predicted physiological maturity was within 5 days of the actual physiological maturity date.

The final test in this study was to compare the regression equation (2) with the equation used by Vanderlip and Arkin (1977)

Table 4. Comparison of 50:86 growing-degree units regression equation with physiological maturity equation used by Vanderlip and Arkin (1977).

Year, location, and hybrid.	Vanderlip and Arkin model Phys. Maturity	Error	50:86 GDU model Phys. Mat.	Error
1965 Manhattan, Kansas				
RS-610	9-2	+2	9-2	+2
KS-650	9-5	0	9-5	0
KS-701	9-16	+6	9-12	+2
1966 Manhattan, Kansas				
RS-610	9-14	-12	9-23	-3
KS-650	9-15	-11	9-24	-2
KS-701	9-22	-9	10-3	+2
1969 Manhattan, Kansas				
RS-610	9-28	+2	10-5	+9
RS-702	10-8	-6	10-14#	0
1970 Manhattan, Kansas				
RS-610	9-19	-6	9-20	-5
RS-702	10-3	0	10-5	+2
KS-650	9-28	-6	10-5	+1
RS-702	10-14	+6	10-17##	+9
1970 Columbia, Missouri				
E-57	9-18	+1	9-20	+3
RS-702	9-29	+5	9-30	+6
1971 Manhattan, Kansas				
RS-610	9-23	-2	9-23	-2
RS-702	10-4	-5	10-1	-8
KS-650	9-21	+7	9-19	+5
RS-702	9-28	+2	9-27	+1
1971 Columbia, Missouri				
E-57	9-13	+1	9-12	0
RS-702	9-24	+5	9-27	+8
1971 Lincoln, Nebraska				
RS-626	9-19	-13	10-1	-1
1972 Rocky Ford, Colorado				
Neb-505	8-20	-9	8-27	-2
RS-610	8-26	-11	8-31	-6
1974 College Station, Texas				
RS-610	7-10	-2	7-14	+2

	Vanderlip and Arkin model	50:86 GDU model
	$\bar{d}$ = -2.29	$\bar{d}$ = 0.96
	$s\bar{d}$ = 1.29	$s\bar{d}$ = 0.90
	t = -1.78+	t = 1.07ns

freeze date
cold period
+ significant at .10 level
ns not significantly different from zero

in their grain sorghum growth and development model. Their equation estimated physiological maturity based on the number of days from emergence to half-bloom. They defined the number of days from emergence to physiological maturity in their model as 1.6 times the number of days from emergence to half-bloom. Table 4 also shows the results of this comparison. Their equation resulted in an average underestimation of physiological maturity by -2.29 days over all 24 data sets, which was significantly different from zero when tested using the "Student's" t test, where $t = -1.78$ ($P < 0.10$).

Comparing the 50:86 growing-degree units regression equation (2) of physiological maturity with the equation based on the number of days from emergence to half-bloom, used by Vanderlip and Arkin (1977), showed that the growing-degree units regression equation was as good or a better predictor of physiological maturity in 17 of the 24 cases. Using the 50:86 growing-degree units regression equation (2) resulted in a lower average difference from the actual phsyiological maturity date, a lower standard deviation of the mean, and no statistically significant difference from the actual physiological maturity date.

DISCUSSION

The use of temperature-units to predict grain sorghum physiological maturity does show some promise. In this study, a 50:86 growing-degree units system correlated with the planting date was a better predictor of grain sorghum physiological maturity than a system based on a ratio of days from emergence to half-bloom.

Previous attempts to predict physiological maturity of grain sorghum (Clegg et al., 1969, 1970) may have been unsuccessful because the growing-degree equation may have been inaccurate. The equation may have attempted to predict the units from planting to physiological maturity, without considering the various stages of development. There may also have been no attempt to adjust the number of units with planting date, hybrid, or location.

The advantage of this 50:86 growing-degree units regression equation is that it predicts only the number of units from half-bloom to physiological maturity and is adjusted with the planting date. It seems logical that the number of growing-degree units will vary with hybrid and location. This 50:86 growing-degree units regression equation makes no attempt to directly differentiate among hybrids, but the correlation with planting date attempts to indirectly adjust for location, since there is a change in planting date across the U.S. grain sorghum producing area, with generally earlier plantings in the south and later plantings in the north. However, much of the difference among hybrids is time from planting to half-bloom, thus the 50:86 growing-degree units regression equation may partially compensate for hybrid differences since it doesn't consider the number of units before half-bloom.

Undoubtedly this 50:86 growing-degree units regression equation can be improved upon. A 50:80 growing-degree units equation was suggested from the results of this study as one possible improvement. Robertson (1968) suggested that the maximum and minimum temperatures should have both lower and upper critical limits. The 50:86 growing-degree units system used in this study had only an upper limit on the maximum temperatures and a lower limit on the minimum temperatures. Inclusion of additional critical limits could possibly improve on the ability of a temperature-units system to predict the development of the grain sorghum plant. The 24 data sets used to test the 50:86 growing-degree units regression equation (2) included a limited number of data sets from locations other than Manhattan, Kansas. This geographical limitation in the data sets precluded the investigation of possible curvilinear correlation of 50:86 growing-degree units from half-bloom to physiological maturity with planting date. Inclusion of additional data sets, especially early planting dates from the southern U.S. grain sorghum producing region, may warrent the investigation of possible non-linear correlations.

Results of this study show that this 50:86 growing-degree units equation, correlated with the date of planting (r = -.50), to predict grain sorghum physiological maturity is an improvement over the equation based on a ratio of days from emergence to half-bloom. The use of this 50:86 growing-degree units regression equation in the Arkin, Vanderlip, and Ritchie (1976) model will improve the ability to predict grain sorghum physiological maturity.

SUMMARY AND CONCLUSIONS

Various growing-degree unit systems were evaluated for their ability to estimate the number of growing-degree units from planting to physiological maturity in grain sorghum using five years of data on one hybrid at Manhattan, Kansas. The

50:86 growing-degree unit system used by the National Weather Service, which adjusts for maximum temperatures above 86°F and minimum temperatures below 50°F was selected for further study. The 50:86 growing-degree unit system is both a commonly used method as well as being an accurate estimator on the selected data sets. The data base was expanded to include 14 data sets, 5 years and 4 hybrids at Manhattan, Kansas. A regression equation was developed to predict the number of 50:86 units from half-bloom to physiological maturity based on the Julian date of planting, $(r = -0.50)$. This regression equation was tested on the 24 data sets (7 years, 7 hybrids, and 5 locations). The equation error was not significantly different from zero, using the "Student's" t test, and was an improvement on the ratio equation Vanderlip and Arkin (1977) used to predict physiological maturity.

LITERATURE CITED

1. Arkin, G.F., R.L. Vanderlip, and J.T. Ritchie. 1976. A dynamic grain sorghum growth model. Trans. A.S.A.E. 19:622-630.
2. Arnold, C.Y. 1975. Heat unit systems in corn production. Ill. Res. 17(2):10-11.
3. Aspiazu, C., and R.H. Shaw. 1972. Comparison of several methods of growing-degree unit calculations for corn (Zea mays L.). Iowa State J. Sci. 46:435-442.
4. Brown, D.M. 1963. A "heat unit" system for corn hybrid recommendations. Paper presented at 5th National Conference on Agricultural Meteorology, Lakeland, Florida. Ontario Research Foundation, Toronto, Canada.
5. Clegg, M.D., J.D. Eastin, J.W. Maranville, and C.Y. Sullivan. 1969. Maturity and Crop Efficiency. In The physiology of yield and management of sorghum in relation to genetic improvement. University of Nebraska, Annual Report No. 3.
6. Clegg, M.D., J.D. Eastin, J.W. Maranville, and C.Y. Sullivan. 1970. Maturity and Crop Efficiency. In The physiology of yield and management of sorghum in relation to genetic improvement. University of Nebraska, Annual Report No. 4.
7. Eastin, J.D., C.Y. Sullivan, W.M. Ross, M.D. Clegg, and J.W. Maranville. 1971. Comparative developmental stages in sorghum hybrids and parent lines. In The physiology of yield and management of sorghum in relation to genetic improvement. University of Nebraska, Annual Report No. 5.

8. Gilmore, E., and J.S. Rogers. 1958. Heat units as a method of measuring maturity in corn. Agron. J. 50:611-615.

9. Holmes, R.M. and G.W. Robertson. 1959. Heat units and crop growth. Canada Department of Agriculture, Ottawa, Publ. 1042, pp. 32.

10. Madariaga, F.J., and J.E. Knott. 1951. Temperature summations in relation to lettuce growth. Proc. AM. Soc. Hort. Sci. 58:147-152.

11. Pauli, A.W., F.C. Stickler, and J.R. Lawless. 1964. Developmental phases of grain sorghum (Sorghum vulgare, Pers.) as influenced by variety, location, and planting date. Crop Sci. 4:10-13.

12. Quinby, J.R. 1972. Grain filling period of sorghum parents and hybrids. Crop Sci. 12:690-691.

13. Reamur, R.A.F. de. 1735. Observations du thermometre, faites a Paris pendant l'annee 1735, comparees avec celles qui ont ete faites sous la ligne, a l'isle de France, a Alger et en quelques-unes de nos isles de l'Amerique. Paris Memoirs, Acad. Sci. Cited in Meterological Monographs; Recent studies in Bioclimatology, 2:1-3; American Meteorological Society (1954).

14. Robertson, G.W. 1968. A biometeorological time scale for a cereal crop involving day and night temperatures and photoperiod. Int. J. Biometeor. 12:191-223.

15. Robertson, G.W. 1973. Development of simplified agroclimate procedures for assessing temperature effects on crop development. In Plant response to climatic factors. Proc. Uppsala Symp., 1970. (Ecology and conservation, 5.).

16. Shaw, R.H. 1975. Growing-degree units for corn in the north central region. Iowa Ag. and Home Econ. Exp. Sta. Res. Bull. 581.

17. Vanderlip, R.L. 1972. How a sorghum plant develops. Ks. Coop. Ext. Ser. Cir. 447.

18. Vanderlip, R.L., and G.F. Arkin. 1977. Simulating accumulation and distribution of dry matter in grain sorghum. Agron. J. (in press).

19. Vanderlip, R.L., and H.E. Reeves. 1972. Growth stages of sorghum (Sorghum bicolor (L.) Moench.). Agron. J. 64:13-16.

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Plant growth models are useful in simulating effects of environmental, genetic, and management factors on plant growth and development. Accurately predicting grain sorghum (*Sorghum bicolor* (L.) Moench.) physiological maturity has been a problem.

This study developed a linear temperature-unit regression equation, based on date of planting, which estimates the number of 50:86 growing-degree units from half-bloom to physiological maturity. The regression equation was tested on 24 sets of field data from seven years, five locations, and seven hybrids.

The predicted physiological maturity error was not significantly different from zero, using the "Student's" t test, and was an improvement over an equation based on a ratio of days from grain sorghum emergence to half-bloom. Use of the 50:86 growing-degree units regression equation will improve the ability of grain sorghum growth models to predict physiological maturity.