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Correlation equation for synchronized flowering in sunflower (*Helianthus annuus L.*) hybrid KBSH-1 parental lines based on meteorological parameters

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A field experiment was conducted with sunflower hybrid KBSH- 1 parental lines with six monthly sowings to predict the number of days to be staggered between the parental lines to achieve a synchronized flowering based on meteorological parameters. The regression study was made using the different heat unit concepts. The regression co-efficient between the phenophases and the derived weather parameters growing degree days (GDD), relative temperature disparity (RTD), helio thermal units (HTU) and photo thermal units (PTU) clearly indicated the variability between male and female lines with reference to the three phenophases studied. Among the phenophases, highly significant co-efficient was obtained for days to button formation and 50% flowering. Hence, from the study it was concluded that the computed regression equation could be employed to adopt suitable staggering to achieve proper synchronization to get higher seed filling and yield in sunflower hybrid KBSH-1 seed production.

Key words: Sunflower, hybrid parental lines, heat unit concepts, synchronization, flowering, equation.

INTRODUCTION

Sunflower (*Helianthus annuus* L.), 2n = 34 is the second most important oilseed crop in the world next to soybean. In India it is cultivated in an area of 1.33 m ha with productivity of 601 kg per ha and production of 0.80 million tones.

Environmental factors like temperature, relative humidity, rainfall, day length, sunshine hours and light intensity play a major role in deciding the days to flowering, flowering duration and days to completion of flowering. The influence of environmental factors was more pronounced on floral initiation compared to other growth periods (Caddle and Weibel, 1972; Brown et al., 1976). Synchronization of flowering is highly influenced by temperature (Goyne and Hammer, 1982) and thus variation in synchronization has been observed in parental lines of sunflower hybrids on different planting period (Ujjinaiah et al., 1988).

Weather conditions not only influences the flowering duration but also the seed set, seed number and seed yield. Seed set was better in summer (Doddamani et al., 1997) sown sunflower. In contrast, Yadava et al. (1998) observed higher seed set in spring sown sunflower.

Shuster and Boyne (1971) observed increased plant height and leaf number in sunflower plants grown under long day and moderate temperature condition. Similar results were obtained by Owen (1983), Goyne and Schneiter (1988), Chaudhury and Anand (1989) and Shinde et al. (1992).

All these influence flowering and hence results in seed set. In crop like sunflower where cross pollination is in

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Table 1. Regression coefficient using weather parameters for prediction of flowering in A line.

Parameter	GDD	RTD	PTU	HTU	Constant	R^2	F value
September 2002							
Days to button formation	48.73	0.66	-4.20	-0.01	22.93	0.78**	33.28**
Days to 50% flowering	18.78	-0.08	-1.69	-0.04	70.69	0.71**	5.66**
Days to completion of flowering	-0.63	0.27	$2.0x10^{-12}$	0.04	65.41	0.44	1.04
October 2002							
Days to button formation	65.59	-0.15	-5.86	0.01	69.16	0.76**	30.40**
Days to 50% flowering	1.24	0.42	-0.26	-0.01	62.68	0.66*	4.81*
Days to completion of flowering	44.06	0.12	-3.76	0.12	49.38	0.54	0.90
November 2002							
Days to button formation	129.26	0.51	-11.27	0.02	14.39	0.81**	43.26**
Days to 50% flowering	-66.46	0.76	6.10	0.03	-39.44	0.86**	18.71**
Days to completion of flowering	$4.0x10^{-13}$	0.30	-0.03	-0.04	56.05	0.97**	22.45**
December 2002							
Days to button formation	-33.88	1.11	3.41	0.02	-102.29	0.74**	27.06**
Days to 50% flowering	$1.0x10^{-11}$	-0.21	0.13	0.13	19.44	0.63**	6.95**
Days to completion of flowering	0.21	0.00	-0.03	-0.07	75.29	0.90	4.51
January 2003							
Days to button formation	-46.65	-0.18	4.22	0.01	-13.34	0.87**	69.80**
Days to 50% flowering	9.40	0.47	-0.49	-0.01	-25.46	0.90**	20.65**
Days to completion of flowering	25.62	-1.13	-2.59	-0.10	222.94	1.00**	56.43**
February 2003							
Days to button formation	6.57	0.14	0.04	-0.06	-98.44	0.36*	5.88*
Days to 50% flowering	2684.58	-0.38	-218.34	-0.05	95.41	0.30	0.87
Days to completion of flowering	1174.59	-0.08	-95.44	0.16	17.90	0.99**	47.03**

*Significance at 1%; **Significance at 5%.

rule, availability of sufficient quantity of viable pollen to pollinate the receptive stigma is necessary for good seed set and higher seed yield. In hybrid seed production, it involves CGMS line where the hybrid seed is produced through cross between male sterile female parent and male fertile restorer line. Hence, synchronized flowering between these two parental lines is first and foremost a prerequisite for higher seed set. But in the case of KBSH-1hybrid parental lines non- synchronized flowering with six days late in male parent was noticed and resulted in poor seed set. How many days to be staggered again depend on the prevailing environmental conditions. Hence, to predict the number of days to be staggered between the parental lines to achieve a synchronized flowering, a study was carried out with six monthly sowing for two consecutive years to get an equation.

MATERIALS AND METHODS

The parental seed material collected from Agricultural Research Station, Bhavanisagar constituted the study materials.

A correlation and regression analysis was made to study the interaction effect on environmental factors on synchronization of flowering (Tables 1 and 2).

The dependable variables were days to button formation, 50% flowering and days to completion of flowering. The independent variables were meteorologically derived parameters.

Meteorological observations

The data on minimum and maximum temperature, sun shine hours and day length were obtained from the " Agromet " documentation of the Department of Agricultural Meteorology, Tamilnadu Agricultural University, Coimbatore and the following heat unit concepts were arrived.

Growing degree days (GDD)

The GDD or the accumulated degree days or effective heat unit is an arithmetic accumulation of daily mean temperature above certain threshold temperature. This was computed using the formula by Iwata (1984). Considering the tropical conditions, base

Table 2. Regression coefficient using weather parameters for prediction of flowering in R line.

Parameter	GDD	RTD	PTU	HTU	Constant	R^2	F value
September 2002							
Days to button formation	55.62	0.39	-4.76	0.05	24.84	-0.76**	33.73**
Days to 50% flowering	106.00	-0.20	-9.29	-0.01	87.98	0.82**	11.45**
Days to completion of flowering	0.37	0.04	$-5.0x10^{-12}$	0.05	57.44	0.60	2.48
October 2002							
Days to button formation	73.34	0.03	-6.62	0.02	82.56	0.76**	34.52**
Days to 50% flowering	-0.39	0.01	-0.18	0.02	85.36	0.57	21.93
Days to completion of flowering	-4.37	0.31	0.50	-0.01	37.11	0.76	3.93
November 2002							
Days to button formation	82.89	0.87	-7.27	0.02	8.48	0.73**	30.95**
Days to 50% flowering	1.15	0.33	-0.01	$-5.0x10^{-11}$	30.19	0.08	0.43
Days to completion of flowering	2.21	0.22	0.09	0.01	45.79	0.91*	7.03*
December 2002							
Days to button formation	-78.06	0.06	7.02	0.05	-48.47	0.61**	17.96**
Days to 50% flowering	-70.15	0.06	7.02	0.05	-148.47	0.61*	17.96**
Days to completion of flowering	-9.87	-0.14	0.86	-0.02	70.26	0.80	2.98
January 2003							
Days to button formation	6.09	0.01	0.12	0.00	-107.39	0.40*	7.70**
Days to 50% flowering	-9279.44	-0.69	754.44	0.05	77.76	0.72	5.72
Days to completion of flowering	12560.14	-0.51	-1020.63	0.00	-81.68	1.00	640.15**
February 2003							
Days to button formation	-57.01	-0.06	5.08	$-5.0x10^{-4}$	-15.42	0.90	101.79**
Days to 50% flowering	-34.92	0.27	3.20	0.11	-31.42	0.53	2.82
Days to completion of flowering	$-1.0x10^{-13}$	0.33	0.05	0.11	44.77	0.33	0.32

*Significance at 1%; **Significance at 5%.

temperature was taken as 10°C for sunflower (Yoshida, 1981).

GDD = [(Max temp + Min temp) / 2] - Base temp

Relative temperature desparity (RTD)

The RTD for the cropping period was calculated using the formula givenas follows:

RTD = [(Max temp – Min temp) / Max temp] × 100

Photo thermal unit (PTU)

Photo thermal unit for each monthly sowing was calculated using the formula suggested by Major et al. (1975).

PTU = GDD x mean day length

Helio thermal unit (HTU)

Helio thermal unit for every crop was computed using the formula by Sastry and Chakravarthy (1 982).

HTU = GDD x number of bright sunshine hours

All the above meteorological parameters were worked out from sowing up to days to button formation, days to 50% flowering and days to completion of flowering for all six sowings (Table 3).

RESULTS AND DISCUSSION

In respect of days to button formation, 50% flowering and completion of flowering between female and male parents, the results revealed that the male line took comparatively more number of days to than female line.

With reference to female line, among the months of sowing, the three phenophases namely days to button formation, 50% flowering and days to completion of flowering were more or less similar between September and October sowings. Subsequent delayed monthly sowing enhanced the number of days for flowering. Some deviation was seen in the male parent where each

Table 3. Correlation co-efficient values among days to button formation and heat unit concepts in parental lines of sunflower hybrid KBSH-1.

Parameter	FD	GDD	PTU	HTU	RTD
FD	1.000	0.584*	0.577*	0.606*	0.530
GDD		1.000	0.992**	0.588*	0.011
PTU			1.000	0.656*	0.084
HTU				1.000	0.684*
RTD					1.000

Table 4. Correlation co-efficient values among days to 50% flowering and heat unit concepts in parental lines of sunflower hybrid KBSH-1.

Parameter	FD	GDD	PTU	HTU	RTD
FD	1.000	0.657*	0.235	-0.399	-0.066
GDD		1.000	0.754**	0.263	-0.101
PTU			1.000	0.404	-0.242
HTU				1.000	0.071
RTD					1.000

Table 5. Correlation co-efficient values among days to days to completion of flowering and heat unit concepts in parental lines of sunflower hybrid KBSH-1.

Parameter	FD	GDD	PTU	HTU	RTD
FD	1.000	0.335	0.433	0.776*	-0.048
GDD		1.000	0.943	0.647*	0.142
PTU			1.000	0.729**	0.100
HTU				1.000	0.222
RTD					1.000

monthly sowing had some pronounced increased days for the three phenophases.

Among the months of sowing, a minimum difference of five days was observed in October sowing between female and male parent in respect to 50% flowering, while in other cases, it was greater. For the regression co-efficient of male parent for different derived weather parameters namely GDD, RTD, HTU and PTU, the 'F' value was significant for days to button formation and days to 50% flowering for September and December sowing, respectively while in other sowings, days to button formation alone showed significant 'F' value. Days to completion of flowering for the crops sown during November showed significant 'F' value.

In respect to female parent, November and January sowings exhibited significant 'F' values for different derived weather parameters for the three indices evaluated. In respect to monthly sowings taken up at September, October and December only two indices viz., days to button formation and 50% flowering had significant 'F' values. Using the correlation between the flowering behavior and heat unit concepts, prediction equation were arrived at for days to button formation, 50% flowering and completion of flowering. The correlation between button formation duration and heat unit concepts indicated that significant correlation existed between the male and female line in days to button formation, GDD, PTU and HTU on one hand, and on the other hand the relative temperature disparity showed non-significant different correlation (Tables 4 and 5).

The regression equation arrived at for predicting the differences between female and male line for days to button formation was:

$$Y = 1 + 0.02\ (GDD) + 0.004(PTU) - 0.04\ (HTU) - 0.003\ (RTD)$$

Where, Y = difference between female and male parent for days to button formation. The adjusted R^2 value was 0.92 which was highly significant.

The correlation between days to 50% flowering and heat unit concepts indicated that only GDD contributed to the variation in 50% flowering. There was no correlation for other meteorologically observed parameters studied.

The regression equation based on the above correlation study can be written as:

$$Y = 3 + 0.1 (GDD) - 0.002 (PTU) - 0.004 (HTU) - 0.01 (RTD)$$

Where, Y = difference between female and male parent for days to 50% flowering.

The R^2 value was highly significant ($R^2 = 0.75$) which explained the variation to the tune of 75%. The correlation between days to completion of flowering and meteorologically derived parameters indicated that correlation existed between days to completion of flowering and photo thermal unit and helio thermal unit. The other heat unit concepts did not show any correlation for completion of flowering.

The regression equation arrived at can be written as:

$$Y = 17 - 0.1(GDD) - 0.002 (PTU) + 0.01(HTU) - 0.02 (RTD)$$

Where, Y = difference between female and male parent for days to completion of flowering. The adjusted R^2 value to degrees of freedom was 0.65 which was significant.

The results further indicated that more of heat unit concepts namely GDD, PTU, HTU had significant contribution for days to button formation, while for 50% flowering, the heat unit concept GDD was the only parameter which caused significant difference and for days to completion of flowering HTU had significant influence.

The regression study was made using the different heat unit concepts. The regression co-efficient between the phenophases and the derived weather parameters (GDD, RTD, HTU and PTU) clearly indicated the variability between male and female lines with reference to the three phenophases studied. It was quite natural to observe such variation, when sowing was taken on monthly basis.

Among the regression co-efficient for the phenophases arrived at from the observed weather parameters, highly significant co-efficient was obtained for days to button formation and 50% flowering. Hence, from the study it was concluded that the computed regression equation would be employed to adopt suitable staggering to achieve proper.

ABBREVIATIONS

CGMS, Genetic cytoplasmic male sterility; **HTU,** helio thermal unit; **PTU,** photo thermal unit; **RTD,** relative temperature disparity; **GDD,** growing degree days.

REFERENCES

Brown RF, Wilson GL, Slater WG (1976). Environmental influences on panicle development. Sorghum Newsletter. 19:2.

Caddle JK, Weibal DE (1972). Photoperiodism in sorghum. Agron. J. 64:473-476.

Chaudhury SK. Anand IJ (1989). Seasonal influence on seed set in sunflower. Crop Improv. 16(1):84-86.

Doddamani IK, Patil SA, Ravikumar RL (1997). Self compatibility and seed set in selected genotypes of sunflower *(Helianthus annuss* L.) Crop Improv. 24(2):207-212.

Goyne P, Hammer J (1982). Phenology of sunflower cultivars. II. Controlled environments studies of temperature and photoperiod effects. Aust. J. Agric. Res. 32(2):251-261.

Goyne PJ, Schneiter AA (1988). Temperature and photoperiod interactions with phenological development of sunflower. Agnon. J. 80(5):777-784.

Iwata F (1984). Heat unit concept of crop maturity. In: "Physiological aspects on Dry land Farming". (ed. Gupta, U.S.). Oxford and IBH. New Delhi. pp. 351-370.

Major DJ, Johnson DR, Tanner JW, Anderson IC (1975). Effect of day length and temperature on soybean development. Crop Sci. 15:174-179.

Owen DF (1983). Differential response of sunflower hybrid to planting date. Agron. J. 75:259-262.

Sastry PSA, Chakravarthy NVK (1982). Energy summation of indices for wheat crop in India. Agric. Met. 27:45-48.

Shinde RM, Powar BB, Dumbre AD (1992). Stability of yield and yield components of sunflower. J. Maharastra Agric. Univ. 7(1):135-136.

Shuster W, Boye R (1971). The influence of temperature and day length on different sunflower varieties under controlled climate conditions and in the open. Fld, Crops Absts. 65(2):4252.

Ujjinaiah VS, Shambulingappa KG, Seenappa K (1988). Effect of sowing dates on synchronization of flowering in BSH-1 sunflower parents. Curr. Sci. 1(7):88-90.

Yadava DK, Sangwan RS, Dahiya BS, Yadav O (1998). Studies on planting ratios for hybrid seed production in sunflower (*Helianthus annuus* L.). Crop Res. 15(2/3):250-255.

Yoshida (1981). Fundamentals of rice crop science. IRRI, Phillipines, P. 267.