



Original Research Article

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Thermal Indices and Yield Correlations of Sesame (*Sesamum indicum* L.) during Summer in New Alluvial Zone of West Bengal

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The effects of 4 sowing dates (15February, 1March, 15March and 1April) on phenology and thermal indices of 3 varieties (Tilottama, Rama and Savitri) of sesame (*Sesamum indicum* L.) was studied in split-plot design with 3 replications at Bidhan Chandra Krishi Viswavidyalaya, Jaguli, Nadia, West Bengal during *pre-kharif* (summer) season of 2017. Delay in sowing of sesame from 15 February to 1 April shortened the duration of sesame by 24.8 days (100.2 vs. 75.4 days). Mean summed growing degree days (GDD), heliothermal unit (HTU) and photothermal unit (PTU) for entire life cycle of sesame were recorded as 1584.87°C day, 10871.8°C hour and 19607.98°C hour, respectively. The correlation studies revealed that GDD ($r = -0.893^{**}$) and PTU ($r = -0.898^{**}$) during flower initiation to capsule initiation showed negative ($P < 0.01$) effect on seed yield of sesame in New Alluvial Zone of West Bengal.

Introduction

Sesame (*Sesamum indicum* L.), one of the oldest oilseed crops, is traditionally grown in our country for thousands of years. In West Bengal, it is cultivated during *kharif* and *pre-kharif* season with low inputs less care and management. It occupies 1.96 lakh ha land with the production of 1.85 lakh tonnes and productivity of 942kg ha⁻¹ in the state during

2013-14. Among different cultivation practices, sowing time is an important parameters which affect the production of sesame to a great extent. The phenological development of sesame varieties under different growth environment along with related thermal indices have not been determined and correlated with the yield of the crop in India, more preciously in the state of West Bengal. The low yield of sesame

varieties under delayed sown conditions leads to discourage growers resulting to less total area under sesame cultivation.

Although genetic potentiality of varieties is important for improved yield and quality of sesame, but sowing time influences the growth and production to a great extent. Sharma (2005) reported 69 and 39% variation in seed yield of sesame due to differences in temperature and variety, respectively. In the background, it becomes imperative to identify suitable sowing date and varieties of sesame during pre-kharif season in the New Alluvial Zone of West Bengal.

Materials and Methods

A field experiment was conducted at the Instructional Farm ($22^{\circ}93'$ N latitude, $88^{\circ}53'$ E longitude and 9.75 m altitude) of Bidhan Chandra Krishi Viswavidyalaya (BCKV), Jaguli, Nadia, West Bengal during summer (*pre-kharif*) season of 2017. The treatments, replicated thrice in a split-plot design consisted of 4 sowing dates (15February, 1March, 15March and 1April) in main plots and 3 sesame varieties (Tilottama, Rama and Savitri) in sub-plots. The soil was well-drained gangetic alluvial, neutral in reaction (pH 7.0), low in organic carbon (0.57%), available N (330.4 kg ha^{-1}), P (44.5 kg ha^{-1}) and K (238.6 kg ha^{-1}). Seeds of sesame varieties were sown in furrows at 30 cm apart in $4 \text{ m} \times 3 \text{ m}$ plots and thinning was done at 18 days after sowing (DAS) to maintain optimum population. A uniform fertilizer does of 60:40:40 kg/ha of N: P_2O_5 : K_2O including N in 2 splits was applied to all the experimental units. Sesame as a *pre-kharif* crop was grown under norwester showers along with need-based irrigation during the cropping period.

The phenophases (*viz.* emergence, flower initiation, capsule initiation and maturity) of

sesame varieties at different sowing dates were noted by regular field inspection method. The daily meteorological data for the period of investigation were collected from the Department of Agricultural Meteorology and Physics, BCKV, West Bengal. Growing degree days (GDD) [$(T_{\max} + T_{\min})/2 - T_b$] was calculated taking 10°C as base temperature (Nuttonson, 1955), heliothermal unit (GDD \times Bright sunshine hour) (Singh *et. al.*, 1990) and photothermal units [GDD \times Day length] Nuttonson (1948). The correlation studies between thermal indices and seed yield were made. The data obtained in the study were analyzed using ‘Analysis of Variance’ technique (ANOVA) following standard statistical procedures (Gomez and Gomez, 1984).

Results and Discussion

Four phenophases of sesame crop were studied; sowing to emergence (S-E), emergence to flower initiation (E-FI), flower initiation to capsule initiation (FI-CI) and capsule initiation to maturity (CI-M) in the study. The duration of 15 February sown sesame crop was 100.2 days, which was reduced by 91.1 days (1 March), 85.3 days (15 March) and 75.4 days (1 April) for delay in sowing in the investigation (Table 1). Sondarva *et al.*, (2014) reported the similar trend of successive decrease in duration of sesame for delay sowing from February to March at Gujarat, India. Based on life cycle, three sesame varieties could be arranged as: Tilottama (91.2 days) > Savitri (87.0days) > Rama (85.2 days).

Mean GDD from sowing to emergence (E), flower initiation (FI), capsule initiation (CI) and maturity (M) were 76, 512, 188 and 807°C days, respectively (Table 2). Like phenophase duration summed GDD for entire life cycle of sesame was gradually decreased with delay in sowing from 15

Table.1 Effect of sowing date and variety on phenology and thermal indices of sesame during pre-*kharif* season

Treatment	Sowing to emergence (S – E)	Emergence to flower initiation (E – FI)	Flower initiation to capsule initiation (FL – CI)	Capsule initiation to maturity (CL – M)	Sowing to maturity (S- M)
Growing degree days (°C days)					
Sowing date					
15 February	81	505	238	886	1710
1 March	83	511	185	843	1621
15 March	59	521	170	805	1555
1 April	82	511	162	697	1452
S. Em (±)	1.49	1.66	3.53	5.09	4.80
CD (P=0.05)	5.28	5.86	12.45	17.98	16.94
Variety					
Tilottama	86	534	204	830	1654
Rama	69	495	179	789	1533
Savitri	73	507	184	804	1568
S. Em (±)	1.91	2.82	1.85	4.07	5.02
CD (P=0.05)	5.78	8.53	5.61	12.30	15.17
Heliothermal unit (°C days)					
Sowing date					
15 February	297	3412	1507	6354	11570
1 March	513	3308	1447	5924	11191
15 March	481	3691	670	6060	10902
1 April	641	2824	1261	5098	9824
S. Em (±)	7.07	10.17	29.32	47.27	38.32
CD (P=0.05)	36.39	35.90	103.45	166.76	135.19
Variety					
Tilottama	545	3444	1334	6056	11379
Rama	440	3222	1122	5712	10496
Savitri	465	3260	1207	5808	10741
S. Em (±)	12.03	18.24	15.17	33.01	29.24
CD (P=0.05)	36.39	55.16	45.87	99.81	88.41
Photothermal unit (°C hour)					
Sowing date					
15 February	978	6198	2944	10992	21112
1 March	1017	6286	2298	10457	20059
15 March	730	6449	2082	10010	19270
1 April	1015	6293	2017	8665	17991
S. Em (±)	18.33	20.39	43.82	63.83	57.43
CD (P=0.05)	64.69	71.93	154.60	225.20	202.61
Variety					
Tilottama	1060	6580	2521	10314	20475
Rama	849	6102	2209	9797	18957
Savitri	897	6238	2017	9981	19392
S. Em (±)	23.46	34.73	22.81	50.56	61.84
CD (P=0.05)	70.94	105.03	68.97	152.90	187.01

Table.2 Correlations between plant characters and thermal indices at different growth stages of sesame during *pre-kharif* season

Parameter	Growing degree days (°C day)				Heliothermal units (°C hour)				Photothermal units (°C hour)			
	S-E	E-FI	FI-CI	CI-M	S-E	E-FI	FI-CI	CI-M	S-E	E-FI	FI-CI	CI-M
Plant height	-.354	.369	-.814 **	-.725 **	.783 **	-.101	-.610 *	-.541	-.291	.431	-.821 **	-.719 **
Number of capsules plant⁻¹	-.802 **	-.078	-.722 **	-.288	.189	.263	-.720 **	-.184	-.786 **	.005	-.739 **	-.285
Test weight	-.723 **	-.080	-.807 **	-.693 *	.377	-.058	-.810 **	-.485	-.676 *	-.006	-.824 **	-.687 *
Seed yield	-.526	-.041	-.893 **	-.577 *	.580 *	-.070	-.584 *	-.489	-.488	.035	-.898 **	-.575
Stover yield⁻¹	-.486	-.115	-.907 **	-.873 **	.637 *	-.379	-.575	-.746 **	-.434	-.052	-.909 **	-.871 **
Oil content	-.723 **	-.080	-.807 **	-.693 *	.377	-.058	-.810 **	-.485	-.676 *	-.006	-.824 **	-.687 *

S-E = Sowing to emergence; E-FI = Emergence to flower initiation; FI-CI = Flower initiation to capsule initiation; CI-M = Capsule initiation to maturity
Sample size: n = 36; * Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed).

February (1710°C day) to 1 April (1452°C day). Tilottama required maximum summed GDD (1654 °C day) to complete the life cycle, while Rama had lowest GDD (1532 °C day) from sowing to maturity.

The variation in mean daily temperature and bright sunshine hour among four sowing dates resulted in varied accumulated heliothermal units at different phenophase and life cycle of sesame crop. Early sowing (15 February) of sesame recorded the highest summed total HTU (11570.2°C hour) for entire life cycle, which was gradually decreased due to delay in sowing on 1 March (11191°C hour), 15 March (10902°C hour) and 1 April (9824.2°C hour) in the investigation (Table 1).

Temperature generally governed the onset of different phenophases in sesame crop, but day length had also influence on photothermal requirements of the crop. Mean cultivar summed PTU at different phenophases were recorded as 935°C hour (sowing to emergence), 6306°C hour (emergence to flower initiation), 2335°C hour (flower initiation to capsule initiation), 10030°C hour (capsule initiation to maturity) and 19608°C hour (sowing to maturity) (Table 1).

The correlation studies showed that of the number of capsules plant⁻¹ was negatively ($P<0.01$) influenced by GDD, HTU and PTU during flower initiation to capsule initiation (FI-CI).GDD ($r = -0.577^*$) during flower initiation to capsule initiation and capsule initiation to maturity (CI – M), while HTU ($r = -0.584^{**}$) and PTU ($r = -0.898^{**}$) during FI – CI had negative effect on economic yield of sesame in the investigation. Similar negative influence ($P<0.05$ OR $P<0.01$) of GDD, HTU and PTU as

oil content has noted in the study. Thus low temperature, less bright sunshine and day length during reproductive stage (FI – CI and CI – M) might be desirable for better seed yield and oil content of sesame during pre-kharif season in New alluvial zone of West Bengal.

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