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Effect of thermal regime on growth and development of Indian Brassicas

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ABSTRACT

Field experiments were conducted during rabi seasons of 1996-97 and 1997-98 at research farm of C.C.S HAU, Hisar, to study the effect of thermal regime on growth and development of Indian brassicas. A difference in the accumulated thermal units during various phenophases of the cultivars of Brassica juncea and Brassica campestris was seen. In late sown crop, the higher day and night temperatures during reproductive phase led in forced maturity and reduced time to maturity. Accumulated thermal units had a close relationship between LAI and dry matter accumulation. During grand growth phase, the dry matter had accumulated in geometric progression. Seed yield and numbers of siliqua/m² followed the parabolic growth function, whereas 1000-seed weight showed a sigmoid pattern with thermal units.

Key Words: Drought, coherence, probability, Key areas.

India is one of the major producers of rapeseed and mustard in the world. However, in terms of yield per hectare, its position is one of the lowest when compared to other oilseeds. Plants depend for growth and development on their genetic constituents and environmental conditions. Temperature may exhibit differential quantitative effect on growth and yield, over and above its influence on flowering and crop duration. Difference between the daily mean air temperature and a reference base temperature (heat unit) can be related to plant growth development and maturity. In view of the significance of thermal influence on plant growth, the experiments were conducted to study its effects on growth and development of Indian brassicas.

MATERIALS AND METHODS

The investigation was conducted during rabi (winter) seasons of 1996-97 and 1997-98 at the research farm of Department of Agricultural Meteorology CCS HAU, Hisar (29° 10' N, 75° 46' E and 215.2m a.m.s.l.). The experiment was laid out in split-plot design with three replications. The treatment combinations comprised of three sowing dates (Oct.5, Oct.19 and Nov.5 in 1996 and Nov.24, Dec.4 and Dec.16 in 1997), two plant densities (30 x 15cm and 40 x 20cm) and four varieties. The optimum doses of nitrogen (80 kg ha^{-1}) and phosphorus (40 kg ha^{-1}) were applied through urea and single super phosphate. The crop was inspected at 2 or 3 days interval to follow the phenological events. From these observations, emergence (P_1),

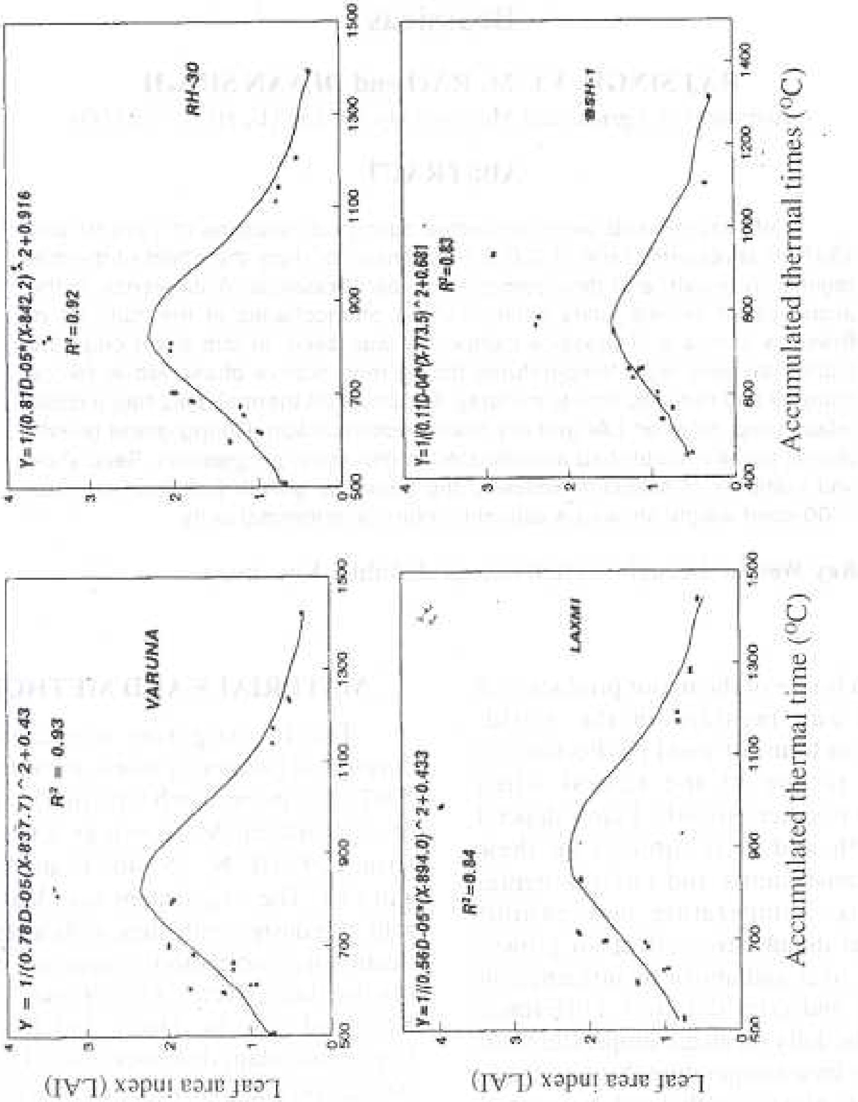

Fig. 1 : Relationship between accumulated thermal time and leaf area index (LAI) in brassicas

first flower appearance (P_2), 50% flowering (P_3), start of seed filling (P_4), end of seed filling (P_5) and physiological maturity (P_6) were identified for each treatment. Five plants were taken randomly for measuring leaf area index and dry matter accumulation at various growth stages. Leaf area of plants selected for biomass observation was measured using leaf area meter (LICOR, LI-3000). The seed yield and its attributes

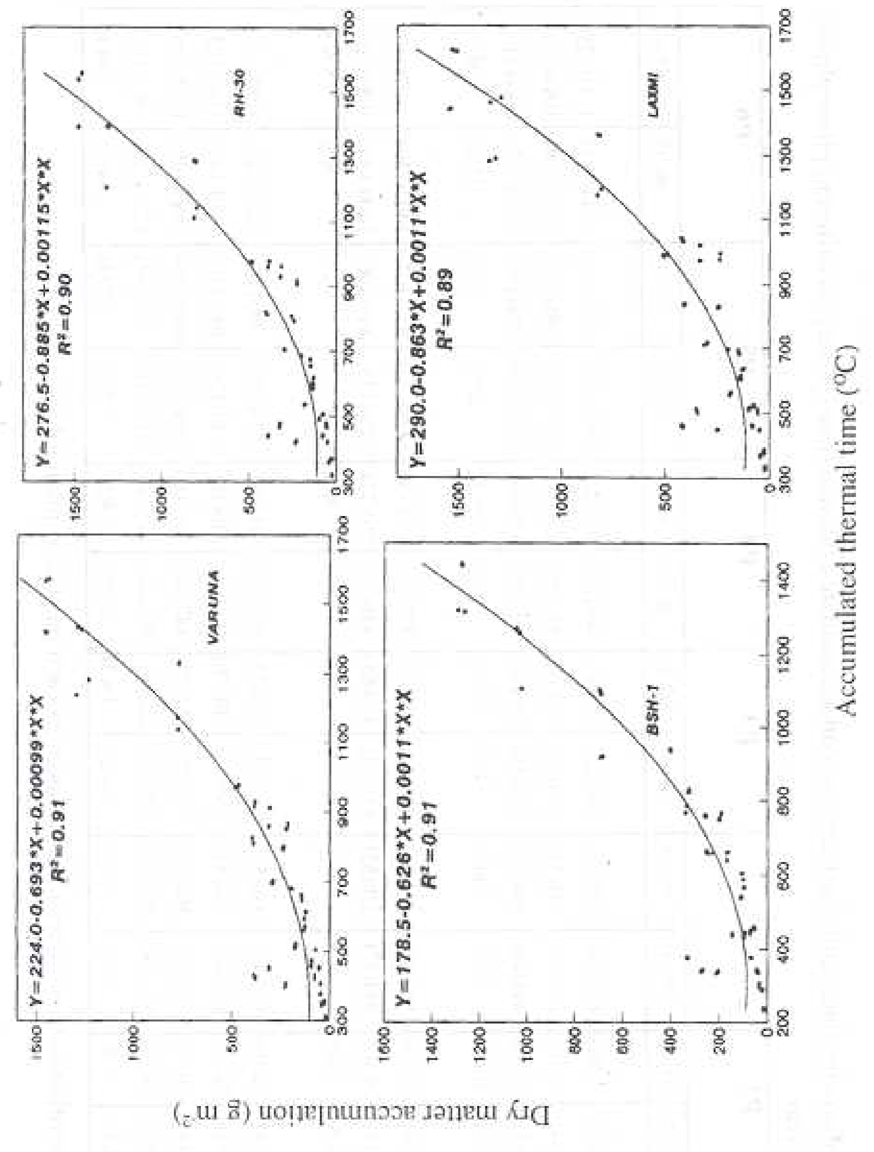

Fig. 2 : Relationship between accumulated thermal time and dry matter accumulation in brassicas

were recorded at harvest in all treatments. The summation of means temperature above a base value (T_b) represents the growing degree-days (GDD). Here T_b is considered as 5°C following Morrison *et al.* (1990).

RESULTS AND DISCUSSION

Thermal units are used for describing the temperature responses to growth and different phenophases of the crop life cycle, the relevant information are shown in Table 1. The total thermal units

Table 1 : Effect of sowing dates and plant densities on accumulated thermal time (°C day) at different phenophases in brassicas

Treatments	P1		P2		P3		P4		P5		P6	
	96-97	97-98	96-97	97-98	96-97	97-98	96-97	97-98	96-97	97-98	96-97	97-98
Sowing Data												
D_1	65(4)	77(8)	652(36)	345(50)	795(47)	426(63)	968(65)	513(74)	1392(127)	939(113)	1544(144)	1131(125)
D_2	74(4)	89(10)	609(42)	348(55)	679(50)	443(66)	812(68)	552(77)	1207(124)	896(107)	1389(139)	1094(118)
D_3	73(5)	55(12)	498(48)	299(50)	585(59)	400(60)	95(78)	479(68)	1096(123)	878(100)	1270(135)	1060(110)
C.D. at 5%	5(0.3)	3(0.4)	9(1)	16(2)	14(2)	28(3)	8(1)	26(3)	20(2)	31(4)	34(2)	35(3)
Plant Densities												
30 x 15 cm	70(4)	73(10)	589(42)	334(52)	686(52)	426(64)	825(70)	519(73)	1228(125)	913(107)	1402(139)	1107(119)
40 x 20 cm	71(4)	74(10)	584(42)	328(52)	687(51)	420(63)	826(71)	510(72)	1236(125)	895(106)	1400(139)	1083(117)
C. D. at 5%	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
Varieties												
Varuna	69(4)	74(10)	592(43)	336(53)	692(53)	516(73)	830(71)	516(73)	1270(129)	888(106	1445(143)	1087(118)
RH - 30	69(4)	74(10)	597(430	350(54)	695(53)	540(750	832/(71)	540(75)	1243(126)	943(110)	1410(140)	1161(122)
Laxmi	74(4)	74(10)	616(45)	362(56)	711(55)	561(78)	847(74)	561(78)	1302(131)	1005(113)	1483(145)	1231(125)
BSH-1	70(4)	73(10)	540(38)	276(44)	647(48)	442(66)	791(66)	442(66)	1113(113)	780(98)	1297(129)	901(107)
C.D. at 5%	N.S.	N.S.	17(2)	12(2)	14(2)	19(2)	11(2)	19(2)	25(3)	47(3)	34(3)	68(4)

The values in parenthesis are number of days taken to each particular phenophase.

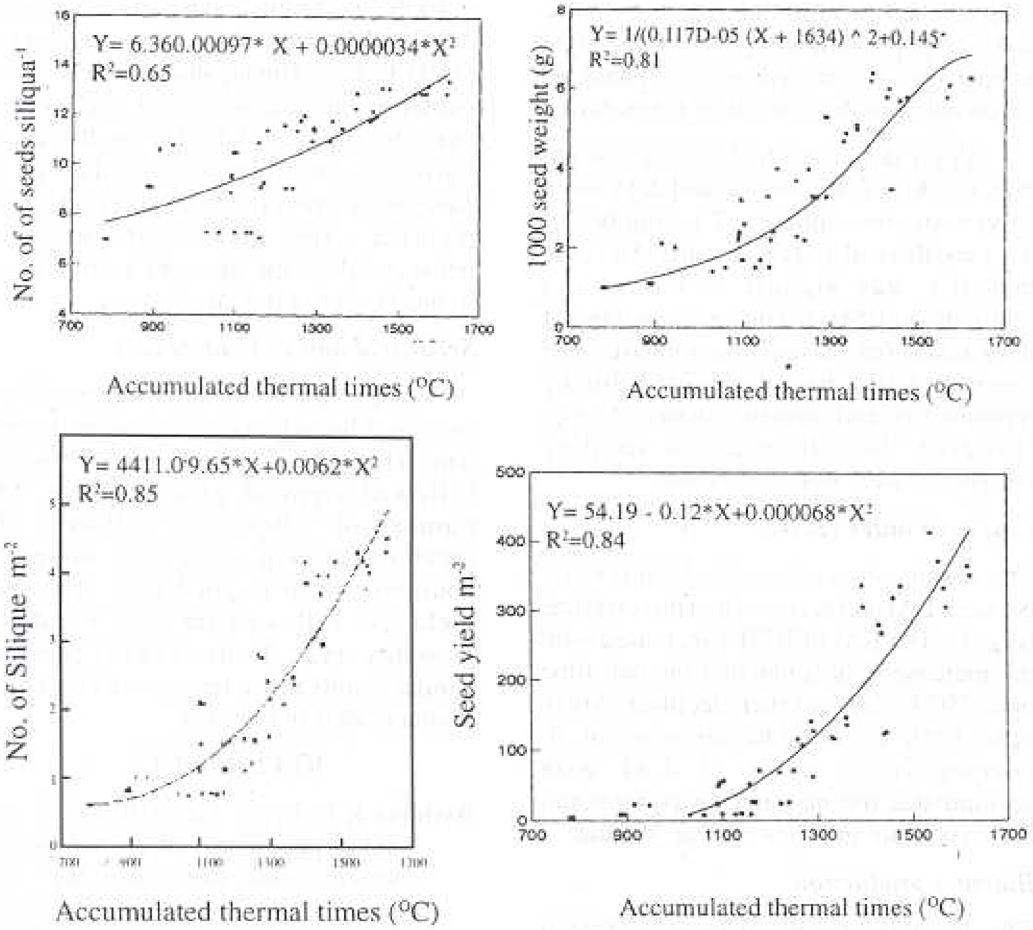

Fig. 3 : Relationship between accumulated thermal time and yield and yield attributes in brassicas

accumulated by the crop to complete its life cycle were more during 1996-97 than 1997-98. The highest thermal units were accumulated in D_1 followed by D_2 and D_3 during both years of study. The differences were significant for all phenophases among the three sowing dates except for seedling emergence in 1996-97 where D_1 accumulated less heat units as compared to latter two sowing dates which were statistically at par. This may be attributed to early germination of seeds because of favourable temperature in D_1 (Prasad, 1989). During 1997-98 crop season the difference among the sowing dates were erratic and showed no specific trend till crop reached the reproductive stage. In late sown crop, prevailing higher day and night temperatures during reproductive phase led to reduction in the time taken for maturity.

Plant densities had no significant effect on heat consumption and days taken to various phenophases. The number of days and thermal units accumulated till crop maturity was highest in Laxmi and minimum in BSH-1. The gap in number of days taken for various phenophases and thermal units became wider during reproductive and maturity phases of crop. However, the differences at seedling emergence were non-significant.

Leaf area index (LAI)

The results showed a close relationship between LAI and accumulated thermal time (Fig. 1). The LAI of BSH 1 increased with the increase in accumulated thermal time upto 750°C day and then declined slowly upto 1350°C day. The response of *B. campestris* in terms of LAI with accumulated thermal times was minimum and maximum in *B. juncea* var. Varuna.

Biomass production

The biomass production at different phenophases was correlated with accumulated thermal time for the pooled data of two years (Fig. 2). The relationship between the biomass accumulation and accumulated thermal time was almost similar in all four genotypes with an initial lag phase during the vegetative growth and thereafter the dry matter accumulated with geometric progression during reproductive phase and on increase in accumulated thermal time. However, the thermal time to reach maturity in BSH-1 was minimum (1400°C day) followed by RH 30 (1500°C day) and highest in Varuna and Laxmi (1600°C day). The lag phase (when the dry matter accumulation was at a slow rate) extended upto 900°C day in *B. juncea* varieties and upto 700°C day in *B. campestris*. Prasad (1989) and Tyagi (1994) reported a very high linear correlation between GDD and biomass accumulation in mustard after the lag phase.

Seed yield and yield attributes

The number of seeds per siliqua increased linearly with increase in thermal time (Fig. 3). The 1000-seed weight followed sigmoid growth curve. The number of siliqua m^{-2} followed the parabolic growth curve with increased consumption of thermal time. The seed yield ha^{-1} followed trend of parabolic growth curve. Rolter (1974) reported similar results in winter rape and Patel and Mehta (1987) in mustard.

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