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Phenological developments and biomass partitioning in *Brassica* as influenced by weather conditions

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ABSTRACT

Three cultivars of *Brassica viz*., Agrani, Pusa Jaikisan and Varuna were sown on three dates (1st, 15th October and 1st November) during two *rabi* seasons of 2000-01 and 2001-02 to study the influence of weather conditions on phenological events and biomass partitioning. It has been observed that early flowering under 1st October sowing resulted in early pod development, longer seed filling period and longer maturity duration which ultimately resulted in higher seed yield than delayed sowing. Delay in sowings resulted in reduction of the biomass accumulation in different plant parts in both the years. However, while comparing the percent allocation to different parts, it was found that the difference was smaller between sowing dates.

Key words : Phenology stages, brassica, biomass partitioning

Brassica is a winter season crop and its physiological and morphological developments are markedly influenced by weather conditions. Phenological development in *Brassica* is considered to be altered primarily by photoperiod, with a general shortening of phases as day length increases (Neelam Kumari *et al*., 1992). Early flowering in crop plants resulted in early siliqua development and increase in reproductive phase and ultimately the seed yield (Shastry and Kumar, 1981). Final grain yield is the product of radiation interception by plants, the efficiency of conversion of intercepted radiation to dry matter and partitioning of photosynthates towards grain filling after anthesis. Therefore the present experiment was undertaken to study the phenological developments and partitioning of biomass in three *Brassica* cultivars under different weather conditions through change in sowing dates.

MATERIALS AND METHODS

The experiment was conducted in two rabi seasons (2000-01 and 2001-02) at research farm of Indian Agricultural Research Institute, New Delhi (28°35 N', 77°10 'E and 228.16m AMSL). The climate of the station is semiarid with dry hot summers and cold winters. The soils of the area are derived from Indo- Gangetic alluvium deposits and are sandy loam in texture. The experiment was conducted in randomized block design. The treatment comprised of combinations of three sowing dates viz., Agrani (V1), Pusa Jaikisan (V2) and Varuna (V3). The recommended dose of fertilizers and packages of other cultural

practices were followed to raise the crop. Phenological events were closely followed by observing the plants on every alternate day. From observations, the following six phenological events were identified:

a) Emergence: The day when 50 per cent germination of seedlings germinated in a plot.

b) First flower appearance: The day when the apical bud opened in to the first flower, in a plot.

c) 50 % flowering: The day when 50 per cent of plants in a plot produced flowers.

d) 90 % podding: The day when pods have already set in 90 per cent plants.

e) End of seed filling: The day on which the pods were completely filled (as they appear & felt by touching).

f) Maturity: The day when 90 per cent of pods in a plot dried, the seeds hardened, turned in to brown colour and crop was ready for harvest. For studying biomass, plant samples were taken at 10 days interval. Three plants were randomly selected from each plot and pulled out every time and separated into leaves, stems and pods. Samples were oven dried for 48 hours and then weighed. Biomass accumulation in different plant parts was then converted to per square meter area basis.

RESULTS AND DISCUSSION

The weather conditions of both the seasons are presented in Fig. 1. It was observed that in the first crop season, the maximum and minimum temperatures were about 2^0C higher during vegetative, flowering and grain filling stages as compared to second season. The total duration of bright sunshine hours remained more or less same during both the seasons. Pan evaporation values were higher by 1.8 mm day^{-1} at seed filling and maturity periods of first *rabi* season. During flowering and pod initiation stages the differences were not appreciable.

Phenological developments

In the first season, the cultivars Agrani, Pusa Jaikisan and Varuna sown on 1st October took less time for emergence as compared to second season (Table1). This may be attributed to the relatively higher maximum and minimum temperatures (by about 2^0C) during the emergence period in the first season. During both seasons, in all the cultivars in the first sowing, the reproductive stage started 5 to 6 days earlier than in second and third sowings. It is remarkable that seed filling stage for all the sowings and all the cultivars took more number of days during second crop season which was comparatively cooler than the first season by 1 to 2^0C. The occurrence of higher maximum and minimum temperatures (weekly mean temperatures by 1 to 3^0 C) at the seed filling period of first season crop probably accelerated the process of seed filling and as a result the duration of seed filling was shortened by 3 to 4 days in different sowings and cultivars during this season as compared to second rabi season. On the whole, it can be concluded that, early

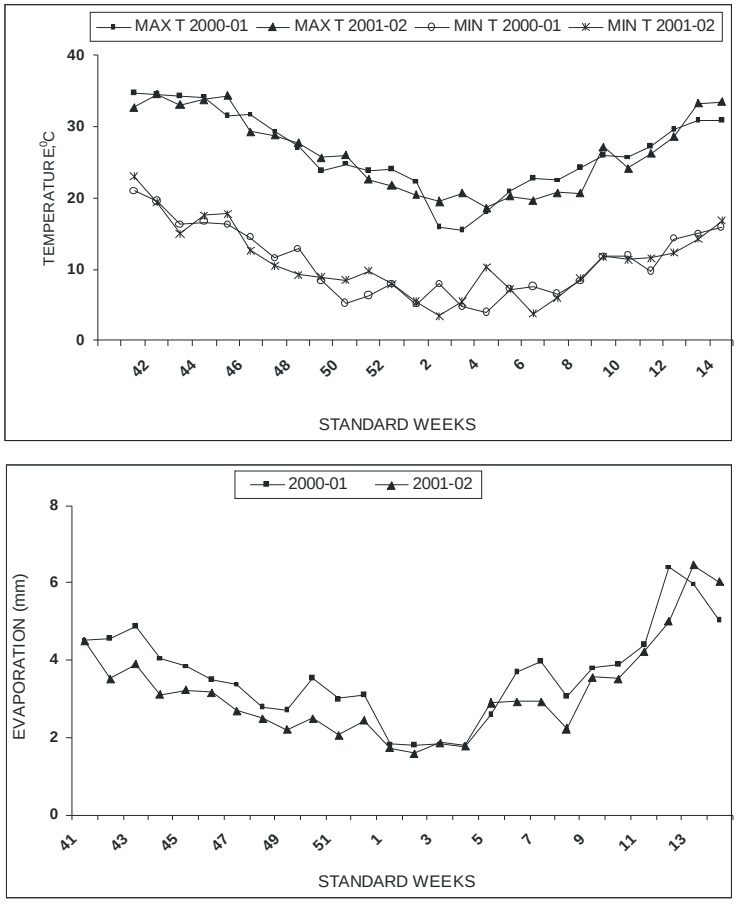

Fig. 1: Mean daily temperatures (maximum and minimum) and evaporation rates during different weeks in *rabi* 2000-01 and 2001-02 seasons

sowing (1st October) resulted in absorbing sufficient amount of heat units in short time due to high temperatures and longer sunshine hours, which resulted in early flowering as compared to late sowings (15th October and 1st November). Early flowering under 1st October sowing resulted in early pod development, longer seed filling period and maturity duration which ultimately resulted in greater seed yield than delayed sowing.

The durations of different phenological events described above were within the range reported by earlier workers (Kar and Chakravarty, 2000 and Tyagi *et al.,* 1996) for *Brassica* spp. For early sown crop (third week of October) Tyagi *et al.* (1996) found that on the average cv. Varuna took 54 to 66 days for opening first flower. They further reported that the number of days taken to maturity of the crop varied from

Table 1: Duration (days) of occurrence of phenological stages from sowing in different species of *Brassica* (I : 2000-01; II : 2001-02 seasons)

Phenological stages	Sea-son	Agrani			Pusa Jaikisan			Varuna			C.V. (%)
		P1	P2	P3	P1	P2	P3	P1	P2	P3	
Emergence	I	9	13	15	9	11	14	11	11	14	18.5
	II	11	9	16	13	10	17	13	11	18	24.0
1st flower	I	27	34	45	33	39	48	37	42	60	28.0
	II	30	34	41	32	42	45	37	46	55	23.8
50% flower	I	37	44	56	43	49	58	48	53	72	6.8
	II	39	43	54	45	53	60	49	57	68	17.7
90% podding	I	72	76	84	91	98	94	103	99	103	23.9
	II	78	83	86	94	102	108	106	110	114	16.7
End of seed	I	96	92	95	119	118	106	130	128	115	37.2
	II	105	102	101	124	122	121	138	131	127	34.5
Maturity	I	111	106	106	135	132	121	148	141	129	13.4
	Ii	124	123	121	141	138	137	156	154	141	14.3

133 days for the late sown crop (30th November) to 143 days for the early sown crop (20th October) while our values are slightly more.

It is revealed from the coefficient of variation (CV) of different phenological stages that the highest CV was observed during seed filling period with values of 37.2 and 34.5 per cent in the first and second seasons, respectively. The lowest CV was observed during maturity period in both seasons, respectively.

Biomass partitioning

From the partitioning of peak above ground biomass in to different component parts of *Brassica* (Fig.2) it can be inferred that the stems accumulated 47 to 57% of total above ground biomass while the accumulation (mean over varieties, sowing dates and seasons) of photosynthates in the pode is close to 45% varying from 38 to 49%. As can be expected, the partitioning to leaves varied from 2 in Agrani to 8% in Pusa Jaikisan.

Similar observations are reported by Patil (1984), Bhargava and Tomar (1988), Rao (1992). Also Kar (1996) showed that in Pusa Bold about 5%, 45 to 49% and 49 to 50% biomass was accumulated in leaf, stem and pod, respectively at maximum biomass accumulation level. Raj Singh *et al.* (2002) reported that in *Brassica sp* .about 0.5 to 2 %, 43 to 59 % and 32 to 63 % biomass was accumulated in leaf, stem and pod, respectively at maturity.

So it can be concluded that delay in sowings resulted in reduction of the biomass accumulation in different plant parts in both the years with certain exceptions. The mean partitioning was forend to be about 51% in

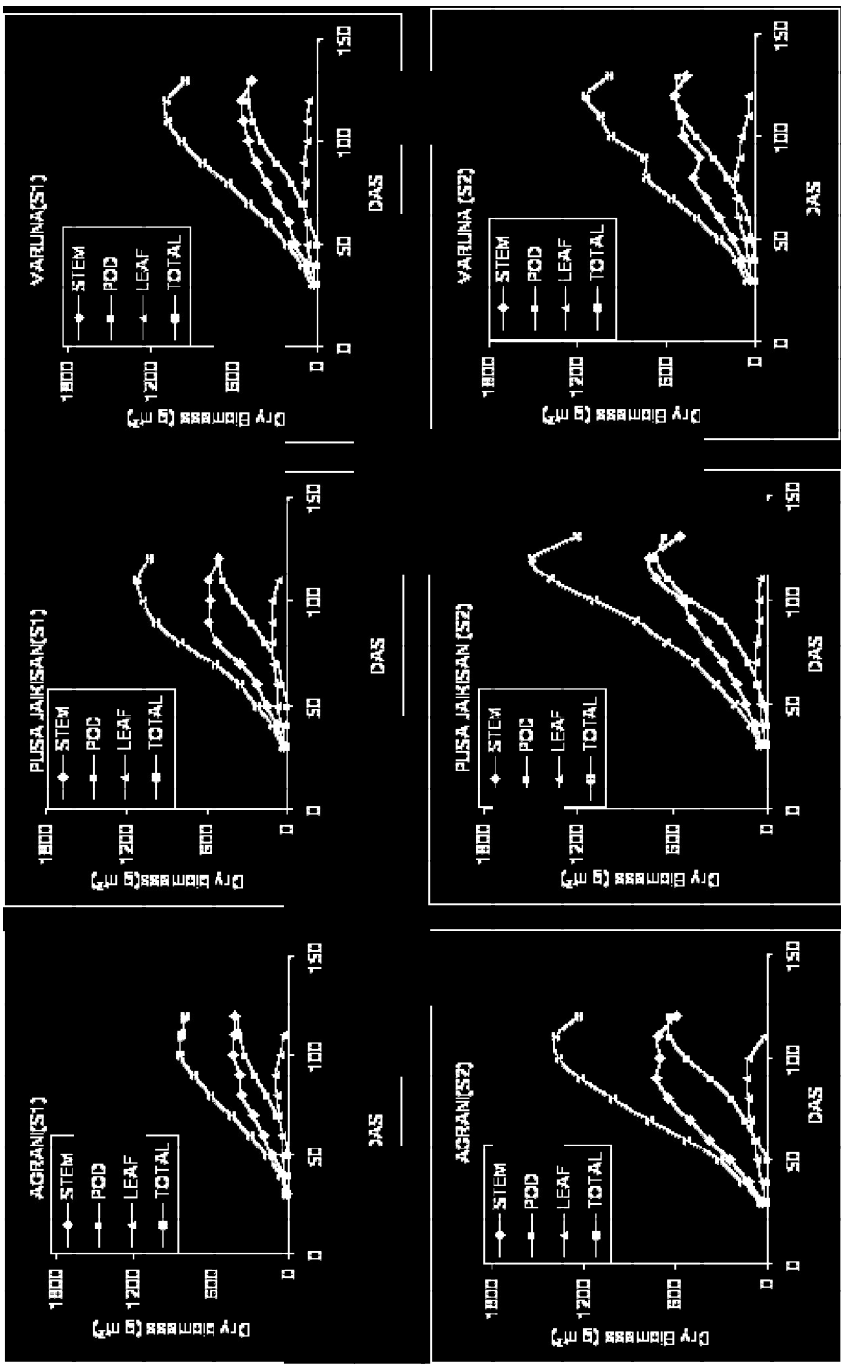

Fig.3 : Biomass partitioning in *Brassica* cultivars in the second planting (15th October) during first (S1) and second (S2) seasons.

Table 2: Partitioning of above ground biomass (g m^{-2}) into different components of *Brassica* at maximum biomass level during two *rabi* seasons 2000-01 (I); 2001-02 (II)

Treatments		Stem	Pod	Leaf	Total
Agrani					
First sowing	I:	438 (50)	376 (43)	61(7)	875
	II:	681 (49)	655 (47)	56 (4)	1392
Second sowing	I:	427 (51)	343 (41)	67 (8)	837
	II:	717 (52)	634 (46)	27 (2)	1378
Third sowing	I:	447 (54)	315 (38)	66 (8)	828
	II:	617 (57)	433 (40)	33 (3)	1083
Pusa Jaikisan					
First sowing	I:	616 (50)	554 (45)	61 (5)	1231
	II:	790 (50)	758 (48)	32 (2)	1579
Second sowing	I:	585 (52)	473 (42)	67 (6)	1125
	II:	743 (50)	708 (47)	45 (3)	1496
Third sowing	I:	495 (50)	455 (46)	39 (4)	989
	II:	535 (47)	512 (45)	91 (8)	1138
Varuna					
First sowing	I:	634 (52)	549 (45)	36 (3)	1219
	II:	663 (50)	637 (48)	26 (2)	1326
Second sowing	I:	546 (50)	491 (45)	55 (5)	1092
	II:	547 (48)	547 (48)	45 (4)	1139
Third sowing	I:	467 (49)	467 (49)	20 (2)	954
	II:	501 (49)	440 (43)	81(8)	1022

(Values in parentheses indicate the percentage of the total biomass)

to stems 45% into pods and 4% to the leaves. This leaves a scope to the breeders to find ways & means to translocate the photosynthate from stem to the pods, which if achieved, will improve the seed yield to a great extent.

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