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Effects of crop climate on capsule volume index and production in sesame under different dates of sowing

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ABSTRACT

An experiment on sesamum crop with eight dates of sowing and three cultivars Kanke-I, Rama and B-67 was carried out in 1993 and 1994 summer seasons. Temperature, relative humidity and photosynthetic active radiation (PAR) were measured at 50 cm above ground level within the canopy. The temperature had direct negative effect on capsule production whereas the humidity and PAR within the crop had a direct positive effect. The capsule volume index was maximum when the crop was sown on February 19. Highest increase in capsule volume index was observed during 40 to 50 DAE under all dates of sowing. The path analysis indicated that temperature and humidity within the crop canopy during 40 to 50 DAE had a direct positive effect on capsule volume index (CVI).

Key words : Sesamum, Capsule volume index, Temperature, Relative humidity, PAR

The yield of sesamum depends on the efficiency of capsule production as well as the capsule volume. High capsule volume index indicates the presence of large number of seeds in the capsule (Chakraborty *et al.* 1984). The capsule production as well as the capsule volume index depend on the physical environment of the crop in which it grows. An attempt has been made to analyse the effect of crop climate on capsule production and capsule volume index in the present investigation.

MATERIALS AND METHODS

An experiment was conducted at the 'C' Block Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, (22°57'N and 88°20'E and 7.8 m above mean sea level) Nadia, West Bengal during the summer seasons of 1993 and 1994. The soil was typical alluvial (Entisol) and sandy loam in texture with pH value 7.40. The total organic carbon, total nitrogen (N), available phosphorus (P) and available potassium (K) status were 0.67%, 0.075%, 13.76 kg ha^{-1} and 149.4 kg ha^{-1} respectively. The zone is classified as having a tropical humid climate (annual rainfall 1500 mm) with three distinct seasons divided into winter (November to February), summer (March to May) and rainy season (June to October). Highest temperatures were recorded in May both in 1993 (35.4°C) and in 1994 (36°C), while the lowest temperatures were 15.6°C (1993) and 15.4°C (1994) recorded in February.

The experiment was carried out in a split plot design with each treatment combination replicated thrice following a standard technique of randomization (Gomez and Gomez, 1984). Treatments consisted of eight dates of sowing viz.

February 10, 19; March 1, 11, 21; April 7, 18 and 28 as main plot measuring 18m x 3m each; three sesame cultivars, Kanke-1, Rama and B-67 were sown in subplots each measuring 6m x 3m. A seed rate of 5 kg ha^{-1} with a row-to-row distance of 25 cm and plant to plant distance of 10 cm were maintained. A recommended fertilizer dose of 60 kg N and 12 kg each of P_2O_5 and K_2O ha^{-1} were applied as basal with urea, single superphosphate and muriate of potash respectively.

Temperature was measured with the help of digital thermometer. A wooden base was prepared with a moveable platform. Digital thermometer was kept at the desired height (50 cm above ground) within the canopy. PAR was measured with the help of LICOR-190SB quantum sensors at the same height. The total number of capsules developed per plant (CPP) was estimated from an average of ten plants per plot. Capsule volume index (CVI) was recorded from 40 DAE and continued upto 70 DAE (days after emergence) at an interval of 10 days. Five second node capsules from five plants were collected and each one was dipped into a water filled graduated test tube to know the volume of the capsule by volume displacement principle. Correlation coefficient and path analysis were carried out for different physical parameters of growing environment on capsule per plant (CPP) and capsule volume index (CVI) following Dewey and Lu (1959).

RESULTS AND DISCUSSION

Effect of dates of sowing on capsule per plant

The results on the effect of dates of sowing on production of capsules per plant (CPP) showed that the maximum number was produced when the crop was sown on February 19 (Table 1). The crop sown on February 10 or in April produced lesser number of CPP, although the extent of

Table 1 : Effect of dates of sowing on the variation in the number of capsules per plant in sesamum cultivars

	1993				1994			
Sowing date	Kanke-1	Rama	B-67	Mean	Kanke-1	Rama	B-67	Mean
February 10	73	89	112	91.3	121	90	103	104.6
February 19	112	135	107	118.2	138	115	106	119.6
March 1	91	112	98	100.3	141	118	99	119.3
March 11	88	96	90	91.3	106	136	113	118.3
March 21	93	101	67	87.0	117	131	105	117.6
April 7	45	38	55	46.0	96	79	72	82.3
April 18	51	57	69	59.0	92	70	68	76.6
April 28	37	38	44	39.6	82	63	72	72.3
Mean	74	83	80		111	100	92	
	± SEm	CD at 5%	CD at 1%		± SEm	CD at 5%	CD at 1%	
Sowing date	7.87	23.88	33.14		3.79	11.50	15.96	
Cultivar	3.17	9.16	12.34		1.45	4.18	5.64	
Sowing date x cultivar	8.98	25.93	34.93		4.10	11.85	15.96	

decline was higher in April sowing than that of February 10. In the April 28th sowing, the extent of reduction was 67 and 40 per cent for 1993 and 1994 respectively in comparison to February 19 sown crop. The CPP got reduced to the extent of 23 per cent in 1993 and 13 per cent in 1994 when the crop was sown on February 10 in comparison to February 19.

Among the cultivars Rama produced significantly higher capsule number than the cultivar Kanke-1 in both the years. In general low production of capsule was observed when sowing was delayed; drastic reduction in April sown crop was observed because 100% flowering was attained in between third week of May and third week of June; premonsoon Nor'wester and monsoon shower seem to have hampered the pollination as well as flowering during this period.

A linear multiple regression and path analysis computed from pooled data (Table 2) showed that high canopy temperature had a direct negative effect on production of capsule per plant. Temperature and PAR at 40 and 50 DAE had direct negative effect on CPP whereas humidity at 40 and 50 DAE and PAR at 30 and 70 DAE had a direct positive effect on CPP. High temperature reduces the light utilization efficiency (Ludlow, 1980), gas exchange (Hamid *et al.*, 1991) and increase the leaf temperature and stomatal

Table 2: Correlation coefficient and path analysis for different physical parameters of growing environment on capsule per plant (CPP) [Pooled value of 1993-94]

	CT_{30}	CT_{40}	RH_{40}	RH_{50}	PAR_{30}	PAR_{50}	PAR_{70}	CPP
CT_{30}	1.00							
CT_{40}	0.550**	1.00						
RH_{40}	-0.346**	-0.371**	1.00					
RH_{50}	-0.351**	-0.640**	0.144	1.00				
PAR_{30}	0.792**	0.726**	-0.417**	-0.420**	1.00			
PAR_{50}	0.622**	0.734**	-0.488**	-0.477**	0.832**	1.00		
PAR_{70}	0.759**	-0.649**	-0.375**	-0.394**	0.895**	0.738**	1.00	
Capsule per plant	-0.471**	-0.577**	0.304**	0.294*	-0.624**	-0.630**	-0.434**	1.00

* Significant at 5% level; ** Significant at 1% level

Path coefficient analysis showing direct and indirect effects :

	CT_{30}	CT_{40}	RH_{40}	RH_{50}	PAR_{30}	PAR_{50}	PAR_{70}
CT_{30}	**-0.0738**	-0.0406	0.0255	0.0259	-0.0584	0.0459	-0.0560
CT_{40}	-0.1405	**-0.2556**	0.0948	0.1635	-0.1855	-0.1876	-0.1659
RH_{40}	-0.008	-0.0085	**0.0231**	0.0033	-0.0096	-0.0112	-0.0086
RH_{50}	-0.0353	-0.0644	0.0145	**0.1007**	-0.0423	-0.0480	-0.0396
PAR_{30}	-0.5878	-0.5388	0.3095	0.3117	**0.7422**	-0.6175	-0.6643
PAR_{50}	-0.1867	-0.2203	0.1464	0.1431	-0.2497	**-0.3001**	-0.2215
PAR_{70}	0.4747	0.4059	-0.2345	-0.2464	0.5597	0.4615	**0.6254**

Diagonal value - Direct effects; Residual effects : 0.7186.

CT, RH, PAR are canopy temperature, relative humidity and photosynthetic active radiation within the crop canopy at 50 cm level from ground respectively. The subscript indicates the days after emergence.

Table 3: Effect of dates of sowing on capsule volume indices of sesamum cultivars

Sowing date	40 DAE Cultivar				50 DAE Cultivar			
	Kanke-1	Rama	B-67	Mean	Kanke-1	Rama	B-67	Mean
Year 1993								
February 10	0.56	0.33	0.43	0.44	0.93	0.86	0.70	0.83
February 19	0.73	0.63	0.57	0.64	1.10	0.83	0.83	0.92
March 1	0.63	0.56	0.46	0.55	1.06	0.86	0.76	0.90
March 11	0.56	0.43	0.53	0.51	1.00	0.83	0.76	0.86
March 21	0.80	0.20	0.40	0.46	1.03	0.80	0.73	0.85
April 7	0.43	0.33	0.43	0.40	0.93	0.73	0.76	0.81
April 18	0.40	0.19	0.32	0.30	0.83	0.83	0.63	0.76
April 28	0.33	0.32	0.23	0.29	0.76	0.80	0.63	0.73
Mean	0.55	0.37	0.42		0.95	0.82	0.72	
	± SEm	CD at 5%	CD at 1%		± SEm	CD at 5%	CD at 1%	
Sowing date	0.02	0.06	0.08		0.02	0.08	0.11	
Cultivar	0.01	0.05	0.07		0.01	0.03	0.04	
Sowing date x cultivar	0.05	0.15	0.20		0.03	0.10	0.14	
Year 1994								
February 10	0.53	0.36	0.46	0.45	0.93	0.86	0.76	0.85
February 19	0.63	0.63	0.58	0.61	1.03	0.93	0.86	0.94
March 1	0.60	0.50	0.46	0.52	1.06	0.86	0.73	0.88
March 11	0.50	0.43	0.46	0.46	1.03	0.76	0.86	0.88
March 21	0.60	0.40	0.40	0.46	1.00	0.83	0.80	0.87
April 7	0.60	0.23	0.43	0.42	0.86	0.73	0.73	0.77
April 18	0.50	0.26	0.33	0.36	0.86	0.70	0.70	0.75
April 28	0.40	0.35	0.23	0.32	0.86	0.66	0.70	0.74
Mean	0.54	0.39	0.42		0.95	0.79	0.77	
	± SEm	CD at 5%	CD at 1%		± SEm	CD at 5%	CD at 1%	
Sowing date	0.03	0.10	0.13		0.02	0.06	0.09	
Cultivar	0.01	0.05	0.07		0.01	0.04	0.06	
Sowing date x cultivar	0.05	0.15	0.20		0.05	0.14	0.19	

Table 3: Contd...

Sowing date	60 DAE Cultivar				70 DAE Cultivar			
	Kanke-1	Rama	B-67	Mean	Kanke-1	Rama	B-67	Mean
Year 1993								
February 10	0.83	1.00	0.96	0.93	1.13	0.90	0.86	0.96
February 19	1.13	0.93	0.93	1.00	1.23	1.16	1.03	1.14
March 1	1.16	0.96	0.80	0.97	1.20	1.00	0.96	1.05
March 11	1.13	0.96	0.83	0.97	1.26	0.93	0.90	1.03
March 21	1.20	0.83	0.80	0.94	1.16	0.90	0.83	0.96
April 7	1.16	0.80	0.80	0.92	0.96	0.80	1.00	0.92
April 18	1.00	0.90	0.80	0.90	1.03	0.83	0.83	0.90
April 28	0.86	0.82	0.93	0.84	0.93	0.76	0.73	0.81
Mean	1.06	0.90	0.84		1.11	0.91	0.89	
	± SEm	CD at 5%	CD at 1%		± SEm	CD at 5%	CD at 1%	
Sowing date	0.01	0.05	0.07		0.02	0.08	0.11	
Cultivar	0.01	0.05	0.07		0.01	0.04	0.05	
Sowing date x cultivar	0.05	0.14	0.19		0.04	0.12	0.16	
Year 1994								
February 10	1.06	0.93	0.90	0.96	1.13	0.96	0.90	1.00
February 19	1.26	1.00	1.00	1.08	1.20	1.13	1.03	1.12
March 1	1.26	0.96	0.96	1.06	1.13	1.13	1.03	1.10
March 11	1.13	1.03	0.93	1.03	1.23	1.00	1.03	1.08
March 21	1.23	1.00	0.86	1.06	1.26	1.00	0.86	1.04
April 7	1.10	0.86	0.86	0.94	1.06	0.86	0.90	0.94
April 18	1.00	0.96	0.86	0.94	1.10	0.86	0.80	0.92
April 28	1.06	0.86	0.86	0.93	1.06	0.93	0.76	0.92
Mean	1.14	0.95	0.90		1.15	0.98	0.91	
	± SEm	CD at 5%	CD at 1%		± SEm	CD at 5%	CD at 1%	
Sowing date	0.02	0.08	0.11		0.02	0.08	0.12	
Cultivar	0.01	0.04	0.05		0.01	0.04	0.05	
Sowing date x cultivar	0.04	0.11	0.15		0.04	0.12	0.17	

DAE = Days after emergence

diffusion resistance (Chakraborty, 1994).

The capsule production per plant (Y) was predicted through linear multiple regression equation with temperature, humidity and PAR at 50 cm height in the canopy as independent variables. The regressions are as follows :

$Y = 599.3 - 5.1729\ CT_{40}$, $R^2 = 0.37$

$Y = -202.8 + 2.22\ RH_{40} + 1.82\ RH_{50}$ $R^2 = 0.16$

CT_{40} is Temperature at 40 DAE, RH_{40}, RH_{50} is Relative humidity at 40 and 50 DAE.

About 37% variation in capsule production could be explained through temperature within the crop canopy at 40 DAE and only about 16% variation could be explained through the variation in the relative humidity at 40 and 50 DAE.

The effect of PAR (μ mol-$s^{-1}m^{-2}$) at 30, 50, and 70 DAE on capsule production per plant is as follows

$Y = 144.3 - 0.01789\ PAR_{30} - 0.0099\ PAR_{50} + 0.01261\ PAR_{70}$ $R^2 = 0.50$

Fifty per cent variation in capsule production per plant could be explained through the variation in PAR available at different stages of crop growth.

Variation in capsule volume index

The capsule volume index (CVI) was

Table 4: Correlation coefficient and path analysis for different physical parameters of growing environment on capsule volume index (Pooled value of 1993 - '94).

	CT_{40}	CT_{60}	RH_{50}	Capsule volume index
Correlation coefficient :				
CT_{40}	1.00			
CT_{60}	0.787**	1.00		
RH_{50}	-0.640**	-0.617**	1.00	
Capsule volume index	-0.019	-0.210	0.212	1.00
Path coefficient analysis				
CT_{40}	**0.4897**	0.3839	-0.3122	
CT_{60}	-0.3438	**-0.4369**	0.2695	
RH_{50}	-0.1631	-0.1572	**0.2548**	

* Significant at 5% level; ** Significant at 1% level

Diagonal value - Direct effects; Residual effects : 0.7186.

CT, RH, are temperature and relative humidity within the crop canopy at 50 cm level from ground respectively. The subscript indicates the days after emergence.

estimated at 40, 50, 60 and 70 days (Table 3) after emergence (DAE). The results on correlation and path analysis (Table 4) indicated that the CVI was maximum when the crop was sown on February 19 in both the years. The lowest CVI was observed when the crop was sown on April 28. No significant variation in CVI was recorded when the crop was sown on March 1, 11 and 21; April 18 and 28. Maximum increase in CVI occurred during 40 to 50 DAE under all dates of sowing; the rate of increase was higher when the crop was sown on later dates. The CVI is closely correlated with the yield in sesamum (Chakraborty *et al.*, 1984) and can be used for yield prediction in advance for different sowing dates.

The results of the path analysis indicated that while the temperature within the crop canopy at 40 DAE had exerted the maximum positive direct effect (Table 4) on CVI at 60 DAE it showed a negative effect. Similarly the relative humidity at 50 DAE had a positive effect (Table 4). Temperature and humidity during 40 to 50 DAE had an important role to play to increase the CVI.

When the cultivars were considered, the highest CVI was observed in case of cultivar Kanke-1 and the variation was significant. Results reveal that in the sesamum production measurements at 50 cm height within the canopy on temperature, humidity and PAR could prove useful in predicting capsule production per plant and capsule volume.

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