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Canopy temperture in relation to growth parameters in indian mustard (*Brassica juncea L*)

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ABSTRACT

Canopy temperature (CT) and canopy air temperature difference (CATD) were measured to screen ten genotypes of Indian mustard under irrigated and rainfed condition for determining susceptibility to drought. Genotypes RK8605 and Krishna were found to be the most suitable having better CGR, yield and yield contributing characters under rainfed situations. Inverse but significant correlation was observed between CT and yield components under rainfed condition and vice versa between CATD and yield components. CATD was negatively correlated under rainfed condition but positively correlated with seed yield under irrigated condition.

Key words: Canopy temperature, Canopy air temperature difference, Indian mustard.

Indian mustard commonly grown in tropical and temperate areas is an imporant crop in respect of oil production and contributes a major share in national economy. Canopy temperature measurement under water stress conditions of crop is gaining increasing attention as a selection Index for dehydration avoidance (Blum *et at* 1982; Keener and Kricher 1983; Harris *et al* 1984 and Chaturvedi *et al* 1999) in various crop species.

Canopy temperatures were used for scheduling irrigation (Jackson *et al* 1977; Das *et al* 1990; Kumar and Tripathi 1991) and also to detect crop condition under water stress in wheat, maize and rice (Ingram *et al* 1990; Kumar and Tripathi 1990). In Brassica species such reports are very limited.

Keeping this in view, the present investigation was undertaken to screen Brassica genotypes using canopy temperatures for better yield under stress conditions and to develop its relationship with growth, yield and yield contributing characters.

MATERIALS AND METHODS

The experiment was conducted at university instructional farm Kumarganj (U.P. India) with ten Indian mustard genotypes commonly grown in the region. Varieties tested were NDR-850 (VI), Varuna

(V2), RK-8605(V3), DYS 279 (V4), Vaibhav (V5), Vardan (V6), Krishna (V7), Kranti (V8), CSR 1110 (V9) and Rohini (V10). These varieties were grown under both irrigated and rainfed conserved soil moisture conditions. Morphological observations were taken on the 30, 60 & 90 days of plant growth. Crop growth rate (CGR), relative growth rate (RGR), specific leaf weight (SLW) and specific leaf area (SLA) were calculated using the formula of Evans (1972). Canopy temperature was measured using Infrared thermometer (Model, 110 ALCS). Accuracy of thermometer was $\pm$ 0.5°C at working distance of 2 to 3 metres depending upon target size. Measurement was made between 1200-1400 hrs at 15 day interval. For study of growth parameters and morphological charaters, sampling was done in a square meter area.

RESULTS AND DISCUSSION

Canopy temperature and canopy air temperature difference.

Canopy temperature (CT/Tc) observations indicate that it was relatively warmer (Table 1) in all genotypes of Indian mustard grown under ranfed situation than under irrigated condition at all the stages of crop growth. There was nonsignificant variation among genotypes under both irrigated and rainfed conditions. CT difference of 3-5°C was observed between rainfed and irrigated treatments among all the genotypes. However, genotypes RK-8605 and Krishna maintained relatively cooler CT than others. Nonsignificant difference in CT at 30 days of crop growth but a significant difference at 60 and 90 days of crop growth were observed. There was non significant difference among genotypes and its interaction with irrigation.

Relatively higher CT was observed at 30 days than at 60th or 90th day of crop growth. At the 30th day, relatively warmer climate was prevalent than than at 60 and 90 days of crop growth. Difference of 3-5°C in CT is indicative of high leaf transpiration rate. Canopy air temperature difference (CATD) recorded between 1200 to1400 hrs indicated that all genotypes grown under rainfed situation had higher CATD that in the irrigated treatment. Nonsignificant differences (Table 2) were observed in all genotypes in respect of CATD. However, variety RK 8605 and cv. Krishnna maintained relalively cooler temperature in respect of CATD. On the 30th day of crop growth, irrigation lowered the CATD by 3-4° C which was more pronounced than that at 60 or 90 days of crop growth. Irrigation has shown significant effect on CATD at all stages of crop growth. This observation indicates that some genotypes had potential to maintain lower CATD under both rainfed and irrigated condition which may perhaps be attributed to better water uptake.

Growth analysis parameters

a. Crop growth rate (CGR)

Though CGR increased under irrigated condition (Fig.1) differences were non significant. Among genotypes, at 60 day of crop growth cv.RK. 8605 recorded maximum CGR under both rainfed (23.95 gm^{-2} day^{-1}) and irrigated condtion (24.71 gm^{-2} day^{-1}).

Table 1 : Canopy temperature (CT) of Indian mustard under rainfed (Io) and irrigated (I1) condition.

Genotypes	Canopy temprature °C											
	15DAS		30DAS		45DAS		60DAS		75DAS		90DAS	
	I0	I1	I0	I1	I0	I1	I0	I1	I0	I1	I0	I1
NDR 8501	31.9	27.9	31.3	27.8	27.6	23.1	25.5	21.2	24.9	20.7	24.5	20.3
Varuna	31.6	26.5	31.8	26.1	28.1	23.2	25.9	21.2	25.2	21.6	24.7	21.3
RK 8605	30.5	25.9	30.0	25.7	27.0	23.0	25.0	21.0	24.5	20.5	24.0	20.0
DYS 27-9	31.6	26.0	31.3	25.8	27.6	22.7	25.5	20.8	25.0	20.4	24.5	20.0
Vaibhav	31.4	25.9	31.2	25.9	28.1	23.1	26.0	21.2	24.8	20.8	24.4	20.3
Vardan	31.7	26.2	31.5	26.0	27.3	22.7	25.3	20.8	24.7	20.5	24.4	19.9
Krishna	31.0	25.5	30.8	25.2	27.1	22.9	25.2	21.0	24.5	20.7	24.1	20.2
Kranti	31.7	26.7	31.4	26.5	27.8	23.0	25.8	21.0	24.5	20.7	24.2	20.4
CSR 1110	31.5	26.4	31.3	25.9	28.1	23.4	25.9	21.5	24.9	21.0	24.5	20.5
Ronhini	31.9	26.6	31.7	26.3	28.4	22.2	26.1	20.1	24.8	20.8	24.6	20.2

Statistical analysis

Factors	CD at 5%		
Irrigation (I)	NS	0.12	1.20
Genotypes (G)	NS	NS	NS
I x G	NS	NS	NS

b. Relative growth rate (RGR)

Irrigation treatment significantly affected the RGR of mustard genotypes at different DAS. It was higher in comparison to rainfed treatment at all three stages of crop growth under study. RGR were higher at initial stages but declined by 90 DAS i.e. at maturity stage in all genotypes (Fig.1) in both the treatments.

c. Net assimilation rate (NAR)

It was also found to be higher under irigated conditions than those obtained in rainfed situation. Genotypic variation considerably existed in NAR (Fig.2) in the beginning but at 60 and 90 DAS difference was non significant. Cultivar Varuna was found to possess highest NAR at early stages while at later stage cultivars RK 8605 and Kranti recorded higher NAR. Specific leaf weight (SLW) of cv. Krishna was maximum (Fig.2) under both rainfed and irrigated condition.

d. Dry matter partitioning

Leaf and stem dry matter (Fig.3) were seperately measured at different DAS of crop growth which did not show significant correlation among genotypes under both treatments. Among genotypes, cv. Krishna accumulated highest leaf dry matter

Table 2 : Canopy air temperature difference (CATD) of Indian mustard under rainfed and irrigated conditions.

Genotypes	Canopy temprature °C											
	15DAS		30DAS		45DAS		60DAS		75DAS		90DAS	
	I0	I1	I0	I1	I0	I1	I0	I1	I0	I1	I0	I1
NDR 8501	+1.7	-3.9	+1.5	-3.6	+0.9	-3.6	+0.7	-3.6	+0.7	-3.6	+0.7	-3.5
Varuna	+1.8	-4.3	+1.6	-4.1	+1.3	-3.9	+1.1	-3.6	+1.0	-3.5	+0.8	-3.5
RK 8605	+1.0	-4.1	+0.8	-3.9	+0.7	-3.8	+0.5	-3.8	+0.5	-3.7	+0.4	-3.7
DYS 27-9	+1.7	-4.6	+1.5	-4.4	+0.9	-4.2	+0.7	-4.0	+0.6	-3.9	+0.6	-3.8
Vaibhav	+1.3	-4.0	+1.1	-3.8	+1.4	-3.7	+1.2	-3.6	+0.7	-3.5	+0.6	-3.5
Vardan	+1.7	-4.9	+1.5	-4.7	+0.7	-4.3	+0.5	-4.1	+0.6	-4.0	+0.6	-3.9
Krishna	+1.3	-4.3	+1.1	-4.1	+0.6	-3.9	+0.4	-3.8	+0.3	-3.8	+0.3	-3.6
Kranti	+1.3	-4.6	+1.1	-4.3	+1.2	-4.0	+1.0	-3.8	+0.8	-3.6	+0.4	-3.4
CSR 1110	+1.6	-4.6	+1.4	-3.8	+1.3	-3.5	+1.0	-3.3	+0.9	-3.4	+0.7	-3.5
Rohini	+1.3	-4.2	+1.2	-4.0	+1.5	-4.0	+1.3	-4.0	-1.0	+3.9	-0.8	-3.6

Statistical analysis

Factors	CD at 5%		
Irrigation (I)	0.50	0.38	1.50
Genotypes (G)	NS	NS	NS
I x G	NS	NS	NS

DAS = Days after sowing
NS = Non - significant
I0 = Rainfed
I1 = Irrigated

partitioning where as with respect to stem, highest value was recorded in variety Varuna.

It is evident that there was increasing trend in partitioning into leaf up to 60 DAS in all the genotypes grown in rainfed situation (Fig.3) and thereafter a declining trend is seen in leaf and stem partitioning. Under rainfed condition all genotypes exhibited relatively more dry matter in comparision to irrigated condition.

Yield & yield components

Strong negative correletion was found (Table 4) between canopy temperature and seed yield (r = -0.81), siliqua^{-1} length (r = -0.83), No. of seeds siliqua^{-1} (r = -0.91) and test weight (r= -0.81) under rainfed condition only. In Irrigation treatment, there was nonsignificant relation in all the characters. This clearly shows that increase in canopy temperature had negative effect on seed yield and their yield components. Higher CT had adverse effect on seed development as negative correlation was higher between CT and number of seeds per siliqua (r= -0.91). Genotypes which maintained cooler canopy temperature (CT) in comparison to others had relatively higher yield (Table 3) under

Table 3 : Yield and yield contributing characters of Indian mustard genotypes under rainfed and irrigated condition.

Genotype	Seed yield q ha^{-1}		Test weight (g)		No.of seeds siliqua^{-1}		Siliqua length(cm)		Oil content %	
	I0	I1	I0	I1	I0	I1	I0	I1	I0	I1
NDR 8501	5.7	7.4	4.5	4.6	13.0	13.6	4.6	4.6	38.8	38.5
VARUNA	5.0	8.4	4.6	4.5	14.2	14.5	4.8	5.1	38.4	38.1
RK 8605	8.3	10.3	6.0	6.1	14.2	14.4	4.6	4.7	38.4	38.2
DYS 27-9	5.9	10.5	5.0	5.2	13.2	14.1	4.4	4.6	38.3	38.0
VAIBHAV	5.7	9.1	5.5	5.5	13.6	13.9	5.1	5.6	38.4	38.3
VARDAN	6.5	11.9	5.2	5.3	13.3	13.7	4.4	4.5	39.0	38.8
KRISHNA	7.9	9.9	5.9	6.0	13.5	13.8	4.8	4.9	38.6	38.3
KRANTI	7.9	10.0	4.9	4.9	13.9	13.9	4.4	4.6	39.0	38.8
CSR 1110	6.4	7.6	3.8	4.0	13.6	13.7	4.0	4.4	39.0	38.5
ROHINI	5.0	8.1	5.5	5.7	13.2	13.5	4.7	4.8	39.0	38.5
CD at 5%										
(I)	1.2	0.11	NS	NS	NS	NS				
(G)	2.2	0.22	NS	0.26	NS	NS				
I x G	NS	NS	NS	NS	NS	NS				

I0 = Rainfed I1 = Irrigated

Table 4 : Relationship of canopy temperature (CT) and canopy air temperature difference (CATD) with yield and yield contributing characters (Pooled data)

Yield & Yield Characters	Correlation cofficient			
	CT		CATD	
	I0	I1	I0	I1
Seed yield (q ha^{-1})	-0.81*	-0.36 NS	-0.39*	+0.85*
Seed yield per plant (q)	-0.74*	-0.22 NS	-0.91*	+0.12 NS
Silique length (cm)	-0.83*	+0.44 NS	-0.42 NS	+0.43 NS
Silique length plant^{-1}	-0.78*	+0.42 NS	-0.84*	+0.63*
No.of Seeds silique^{-1}	-0.91*	+0.07 NS	-0.12 NS	+0.06 NS
Test weight	-0.81*	+0.13 NS	+0.13 NS	+0.06 NS

Significant at 5% NS = Non - significant

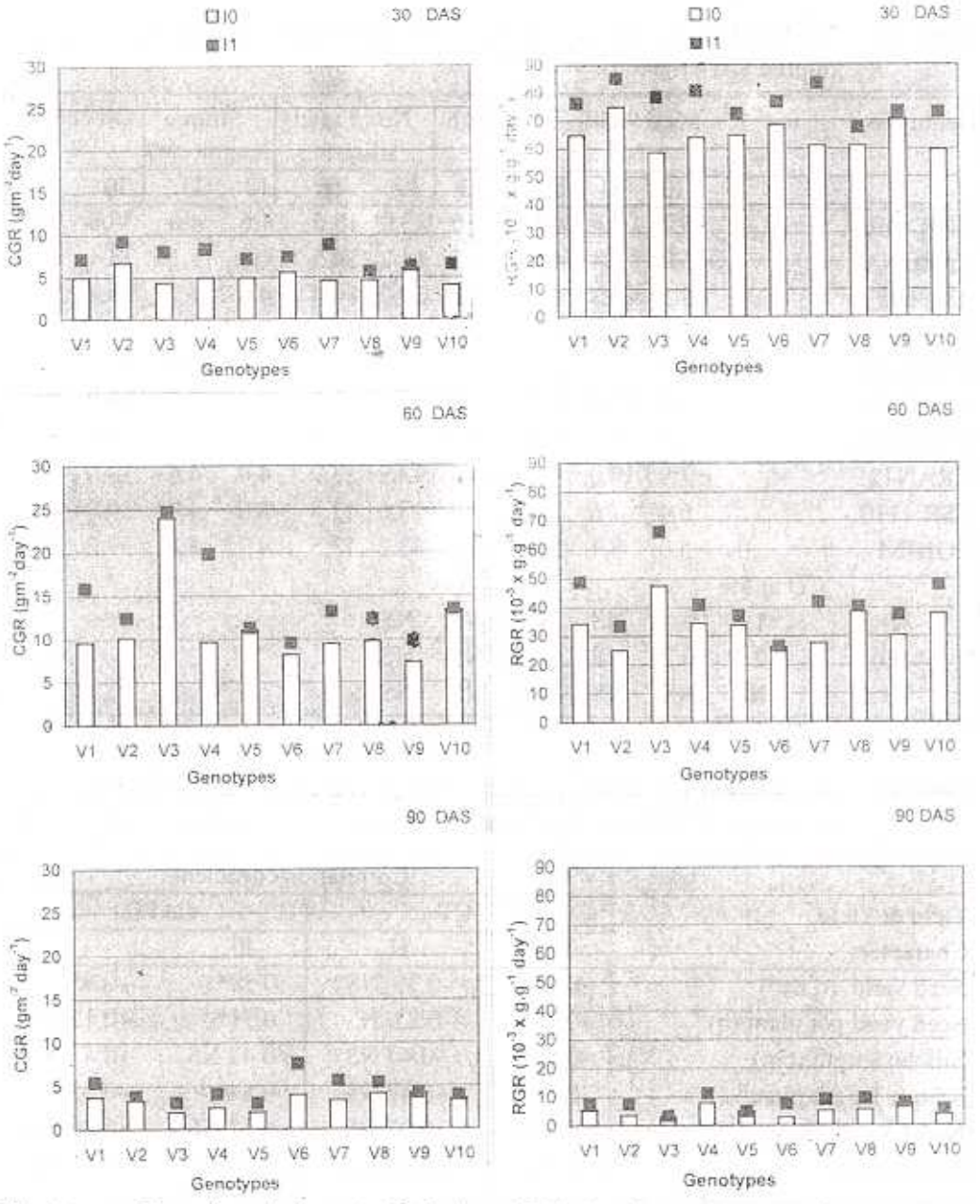

Fig. 1 : Crop Growth Rate (gm^{-2} day^{-1}) and Relative Growth Rate (10^{-3} x $g.g^{-1}$ day^{-1}) variation of Indian mustard under rainfed (10) and Irrigated condition (I1.)

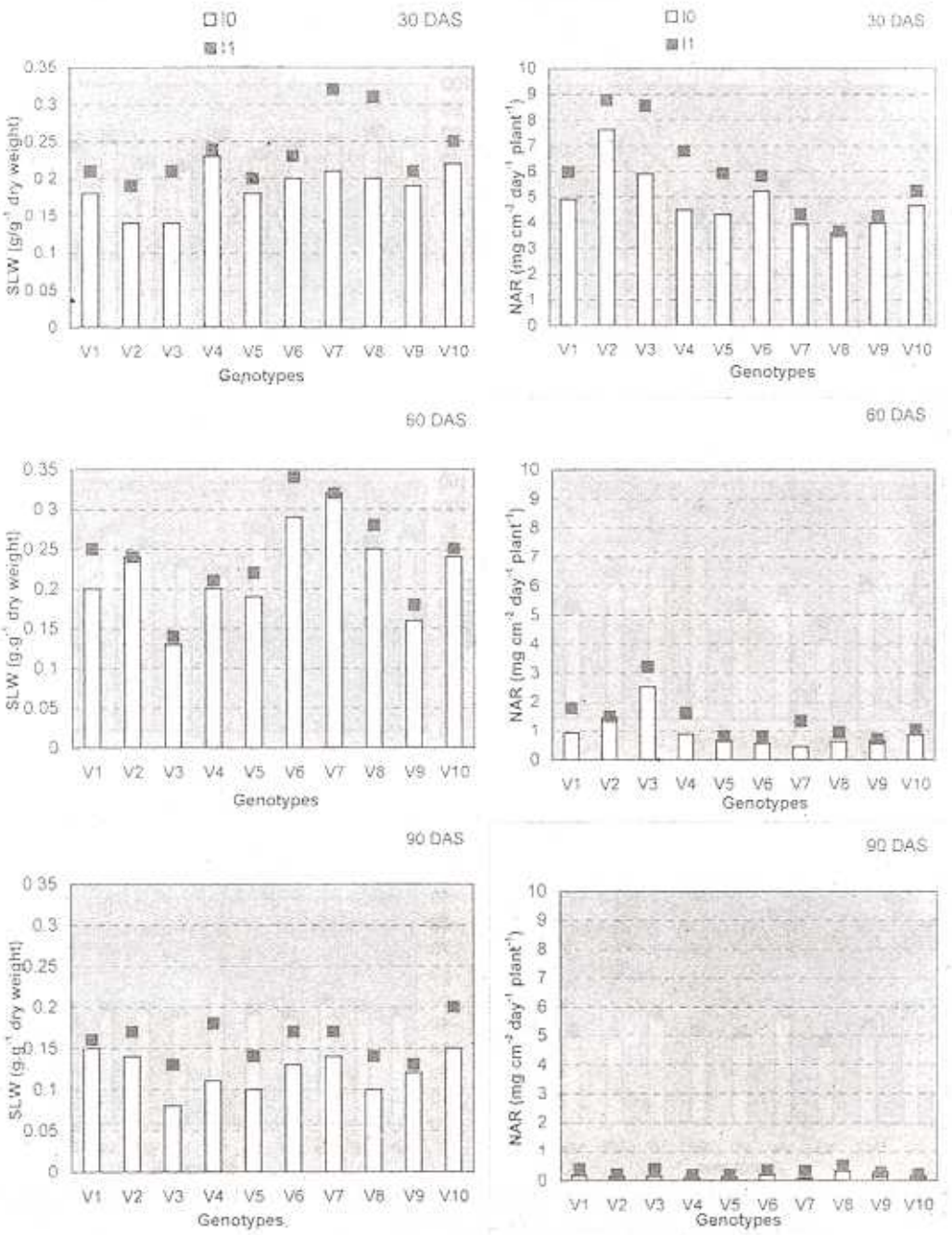

Fig. 2 : Variation of specific leaf weight (SLW) and Net Assimilation rate (NAR) in Indian mustard genotypes.

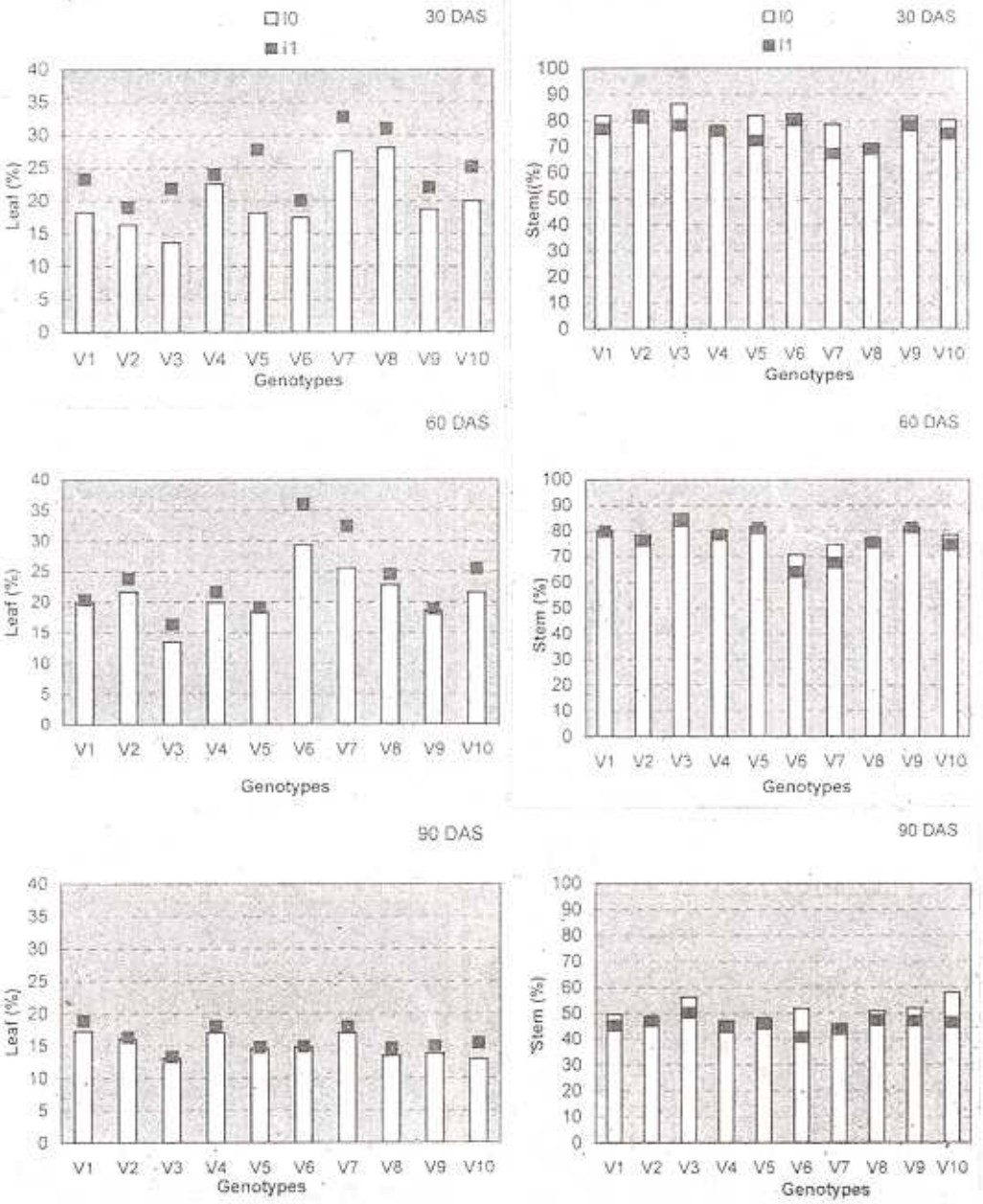

Fig. 3 : Dry matter partitioning on dry weight basis in Indian Mustard under rainfed (I0) and Irrigated (I1) condition.

both irrigated and rainfed conditions. CATD was always positive under rainfed and negative under irrigated condition. Under rainfed conditions, inverse relationship was found between seed yield and canopy air temperature difference (r= -0.89) respectively. In contrast to this (Table 4) irrigation treatment showed correlation between with seed yield (q ha^{-1}) and CATD (r= +0.85).

It is therefore, concluded that genotypes which posses cooler canopy temperature and relatively higher yield than genotypes which had warmer canopy temperature under unirrigated conditions.

REFERENCES

Blum, A.Mayer, J.and Gozlan, G.1982. Infrared thermal sensing of plant canopies as screening teachnique for dehydration avoidance in wheat. *Field Crop Research*, 5:137-146.

Chaturvedi G.S. Padmakar and Kumar, A.1999. Comparative canopy temperature measurement in Indian mustard genotypes *Indian Journal Plant Physiol*, 4(12):10-12.

Das, D.K., Singh, G., Kalara, N. and Sutradhar, A.K., 1990. Remotely sensed canopy temperature of rice crop grown under different moisturte regimes and nitrogen supply. *In proceedings of crop growth and remote sensing, IARI, New Delhi 5-21.*

Evans, G.C.1972. Quantitative analysis of plant growth. Vol. I Black Well Scientific Publications, Oxford, London pp:734.

Harris, D.S., Schapaugh, W.T. and Kanemasu, E.T. 1984. Genetic diversity in soyabeen for leaf canopy temperature and association of leaf canopy temperature and yield. *Crop Science*, 24: 839.

Ingram, K.T., Magulim, J.G., Obien,M.A., and Loresto, G.C. 1990. Comparison of selction indices to screen low land rice for drought resistance. *Euphytica*, 48:260.

Jackson, R.D., Reginato, R.J.and Idso, S.B. 1977. Wheat canopy temperature; a practical tool for evaluating water requirement. *Water Resources Research*, 13:651-656.

Keener, M.E. and Kricher, P.L.1983. The use of canopy temperature as an indicator of drought stress in humid region. *Agricultural and Forest Meteorology*, 28:339-349.

Kumar, A.and Tripathi, R.P.1990. Thermal infrared irradiation for assessing crop water stress in wheat, *Journal of Agronomy and Crop Science*, 165:288-292.

Kumar A and Tripathi R.P.1991. Scheduling irrigation of wheat by canopy temperature in Tarai region. *Journal of Indian Society of Soil Science*, 39:51-55.