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SHORT COMMUNICATION

MORPHO-PHYSIOLOGICAL EFFECTS OF THERMAL AND MOISTURE STRESS ON CHICKPEA GENOTYPES

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Effect of higher temperature (5±2ºC above ambient) on some physiological parameters under moisture stress and non-stress conditions was studied in five chickpea genotypes grown in loamy sand deep soils. There was significant negative correlation between stress grain yield and membrane injury at 50% flowering (r= -0.5269), 20 days after flowering (DAF) (r= - 0.6890), 40DAF (r= -0.8698) and specific leaf area (SLA) (r= - 0.4829) at the podding stage. The genotype RSG 143-1 yielded 18.3q/ha having minimum membrane injury at the above stages and SLA. This genotype also had low flower drop, higher number of filled pods, late senescence and higher harvest index under the stress. Its tolerance to thermal and moisture stress was shown by the lowest thermal (0.19) and drought (0.57) susceptibility indices. It is suggested that better membrane stability and low SLA may help a genotype in maintaining more filled pods and higher grain yield under the stress conditions.

Key words : **Chickpea, membrane injury, moisture stress, specific leaf area, thermal stress.**

Chickpea is an important pulse crop, mostly grown as post rainy season crop in India on about 6-7 million hectare land from 13 to 31 ºN latitude. The crop is mostly grown under rainfed conditions and consequently at the time of pod formation faces thermal stress and terminal drought, drastically reducing its productivity by more than twenty per cent. This effect on productivity is the result of the response of varying physiological processes to the stress environment. Thus it is worth to study the physiological processes under stress environment and to identify the potential physiological traits contributing to the thermal and moisture stress tolerance in chickpea genotypes.

Five chickpea (*Cicer arietinum* L.) genotypes were grown in field with loamy sand (field capacity at 0.1 bars = 8.59%, wilting point at 15 bars = 2.97%) under moisture stress and non-stress conditions in split plot design with stress treatments in main plots and the genotypes in sub plots with three replications. At the time of flower initiation, out of 7.2 sq.m plot area, one square meter area in each plot was covered with 500mm thick, transparent polythene sheet to raise the temperature above ambient by about 5 ± 2ºC at the farm, Agricultural Research Station, Durgapura – Jaipur. The diurnal temperature variation in polyhouses and open plots was measured on three different days during podding stage and the average has been shown (Fig. 1). Some opening/holes were kept in each polyhouse to avoid the rise in humidity. The height of the chambers was about 4.5 feet. Leaf membrane injury was measured according to Sullivan (1972). Thermal susceptibility index (TSI) and drought susceptibility index (DSI) were calculated using the data from non-stress and stress plots with the following formulae :

$$TSI = (Yp-Yt)/Yp\ T \qquad T = 1-(Xt/Xp)$$

$$DSI = (Yp-Ys)/Yp\ D \qquad D = 1-(Xd/Xp)$$

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Where Yp=potential grain yield, Yt=grain yield under thermal stress, Ys=grain yield under moisture stress, Xp=average potential grain yield, Xt=average grain yield under thermal stress, Xd=average grain yield under moisture stress, T=thermal intensity; and D=drought intensity.

The data were analysed for calculating the critical differences and the observations under thermal and moisture stress (combined) have been presented to highlight the genotypic responses.

Temperature at the canopy level in polyhouses was about 5^{o} ± 2 C above the ambient during pod formation stage, thus imposing a thermal stress on the crop (Fig. 1). Also it is evident from the Fig. 2 that the crop experienced drought stress as shown by the lower soil moisture and higher vapour pressure saturation deficit (VPSD) particularly during the pod formation stage.

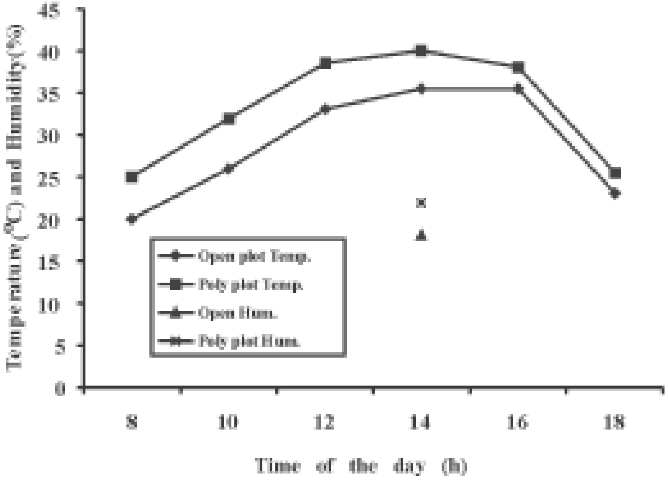

Fig. 1. Variations in temperature and mid day humidity at podding stage

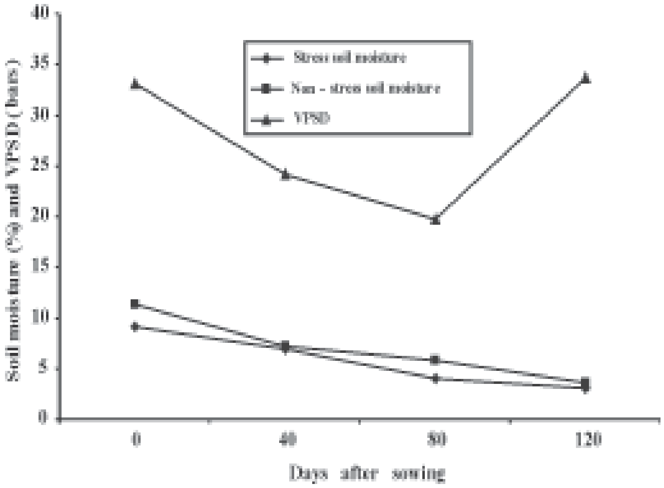

Fig. 2. Variations in soil moisture and VPSD during crop growth period

The response of genotypes to the thermal and moisture stress conditions varied significantly. RSG 143-1 showed maximum tolerance to moisture and thermal stress by expressing the lowest values of DSI and TSI (Table 1). These observations support the earlier report that the genotypes with higher drought tolerance also show heat tolerance (Sullivan 1972). Membrane injury was measured at fifty per cent flowering, 20 and 40 days after flowering(DAF). It was observed that RSG 143-1 maintained low membrane injury at all the stages (Table 1) under the thermal and moisture stress conditions. A significant negative correlation was observed between stress grain yield and membrane injury at fifty per cent flowering (r=-0.5269), 20 DAF (r=-0.6890) and 40 DAF (r=-0.8698). Thus, better membrane stability appears to help the genotype to tolerate the thermal and moisture stress in achieving higher grain yield. Low membrane injury has also been reported to maintain better water use efficiency under moisture stress by the drought tolerant genotypes (Gupta *et al* 2000). Also, better membrane stability has been reported as an expression of drought tolerance in maize and wheat (Premchandra *et al* 1991, Sairam and Saxena 2000). Our study also support the report by Raison *et al.* (1982) who opined that plants with less fluid membranes are better acclimated to higher temperature conditions.

The stress tolerant genotype RSG 143-1 showed low specific leaf area (Table 1) at the podding stage under the stress conditions. Also a significant negative correlation was observed between the stress grain yield and SLA (r= - 0.4829). Thus, low SLA seems to maintain better metabolic status of the source under stress to facilitate development of the pods, as has also been reported by Gupta *et al.* (1989) that a significant positive correlation exists between the photosynthetic rate and the specific leaf weight (SLW, reverse of SLA) at the podding stage. The present observation also supports the earlier report of positive correlation between grain yield and SLW by Katiyar and Katiyar (1994). The observation of Kubiske and Abrams (1992) that xeric seedlings exhibit

Table 1. Variations in stress susceptibility indices, membrane injury and specific leaf area among chickpea genotypes under thermal and moisture stress conditions.

Genotypes	TSI	DSI	Membrane injury (%) at 50%Flowering	20 DAF	40 DAF	SLA (cm^2/g)
RSG 143-1	0.19	0.57	51	54	42	104
RSG 888	2.06	0.66	85	72	59	122
CSJ 103	0.48	1.01	81	50	49	104
CSJ 104	0.84	1.06	58	72	45	108
IPC 92-39	1.62	1.73	73	77	69	117
CD(5%)			3.15	5.84	5.31	4.70

Table 2. Variations in grain yield and some related parameters among chickpea genotypes under thermal and moisture stress conditions .

Genotypes	Grain yield (q/ha)	Filled pods (No./pl.)	Flower drop (%)	Harvest index (%)	Days to 50% senescence
RSG 143-1	18.3	41	33	41	117
RSG 888	12.5	36	30	36	114
CSJ 103	14.2	36	38	42	109
CSJ 104	13.6	28	49	40	112
IPC 92-39	8.4	22	50	36	116
CD (5%)	1.73	3.87	4.50	1.28	0.79

smaller leaf area, greater leaf thickness and specific leaf mass supports the present study that lower SLA helps a genotype in tolerating the stress condition.

It is evident from the Table-2 that the genotype RSG 143-1 was the highest yielder under thermal and moisture stress conditions. The higher yield was due to lower flower drop, more number of filled pods per plant, late senescence and higher harvest index (Table 2). Higher number of pods under stress has also been advocated as a criterion to identify stress tolerant plants by Singh *et al*. (1997). Physiologically active leaves are essential for development of fruits (Sinha 1986) and hence the delayed senescence (more leaf area duration) of active leaves helps the genotype in better grain development under the stress.

Thus it may be concluded from the present study that better membrane stability and low SLA may help a genotype in maintaining more filled pods and higher grain yield under the observed thermal and moisture stress conditions.

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