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Physiological responses in rainfed conditions under high density planting system of cotton

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Abstract
Growth and development physiology of cotton cultivars was studied under drought stress. Study was conducted for two consecutive years *i.e., Kharif,* 2016 -17 and *Kharif,* 2017-18 in the college farm, College of Agriculture, Rajendranagar, PJTSAU. Results during the boll development stage indicate that photosynthetic rate, stomatal conductance and SCMR were recorded maximum in cultivar WGCV- 48 (26.0 μ mol CO_2 m^{-2} s^{-1}, 584 mmol [H_2O] m^{-2} s^{-1} and 36.2 respectively) and transpiration rate was maximum in NDLH-1938 (6.1 mol m^{-2} s^{-1}). WGCV- 48 cultivar showed maximum seed cotton yield (1908 kg ha^{-1}) among all cultivars. Among the spacings studied, 75x10 cm resulted in maximum photosynthetic rate (25.6 μ mol CO_2 m^{-2} s^{-1}), stomatal conductance (626 mmol [H_2O] m^{-2} s^{-1}), transpiration rate (6.15 mol m^{-2} s^{-1}), SCMR (34.7) and seed cotton yield (1639 kg ha^{-1}). Enhancement of plant density increased the intra specific competition. Though a slight decrease in boll weight identified, overall yield per hectare increased when compared to conventional system of wide density planting.

Keywords: Cotton, drought, high density planting system and photosynthetic rate

Introduction
Cotton (*Gossypium hirsutum* L.) is world's leading fiber crop and as a renewable energy source it ranks second among all oil seed crops. It is being grown in 7 major growing nations worldwide and it plays a significant role in global economy. Drought is one of the most important abiotic factors that threatens the modern agriculture productivity and thereby food security. The productivity of cotton is adversely affected by various abiotic and biotic factors, especially water deficit. Drought tolerance is complex, multi -genic trait, which is governed by several genes. The alteration of this gene complex for breeding tolerance could bring changes in yield potential of plant phenotype because of linkage drag. Therefore morphological, physiological, biochemical and molecular basis of drought tolerance needs to be investigated for development of location specific drought resistant varieties has been taken up.

Material Methods
The present investigation was carried out at College Farm, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad. The farm is geographically situated at $78^0$23' E longitude and $17^0$19' N latitude and at an altitude of 542.6 m above mean sea level. It falls under Southern Telangana agro climatic zone of Telangana. The following parameters were quantified in the study.
Photosynthetic rate, rate of transpiration, stomatal conductance measurements were made by using Infra Red Gas Analyser (Model TPS-1) from recently fully expanded leaves, at various stages of crop growth when the stress prevailed. The SPAD-502 (Soil Plant Analytical Development) meter was used for measuring the relative chlorophyll content of leaves. The cumulative yield of seed cotton from three pickings in each treatment plot was weighed and expressed in kg ha^{-1}.

Results and Discussion
Photosynthetic rate
The photosynthetic rate influenced significantly by genotypes and also by plant densities (Table 1). During *kharif*, 2016, maximum photosynthetic rate was recorded by genotype WGCV-48 under 75x10 cm spacing at square stage (11.0 μ mol CO_2 m^{-2} s^{-1}), flowering stage (16.6 μ mol CO_2 m^{-2} s^{-1}) and boll development stage (25.1 μ mol CO_2 m^{-2} s^{-1}). Results of *Kharif*, 2017 also followed similar trend, maximum photosynthetic rate was recorded by

genotype WGCV-48 under 75x10 cm spacing at square stage (11.3 µ mol CO_2 m^{-2} s^{-1}), flowering stage (18.0 µ mol CO_2 m^{-2} s^{-1}) and boll development stage (26.8 µ mol CO_2 m^{-2} s^{-1}). Zhang, 2006 found that photosynthetic rates of cotton at 75-100 DAS grown under 60 x 20 cm spacing (21.7 µ mol CO_2 m^{-2} s^{-1}) is higher than 45x15 cm spacing (20.58 µ mol CO_2 m^{-2} s^{-1}) and 45x10 cm spacing (20.82 µ mol CO_2 m^{-2} s^{-1}). Lawler (1979) [7], reported that net photosynthesis decline in plants subjected to short term moisture stress. Stomata closing in response to moisture stress results in a reduction in leaf photosynthetic capacity resulting in chloroplast dehydration and decreased CO_2 diffusion into the leaf (Khan, 2018) [6].

Transpiration rate

The transpiration rates were found improved due to increased metabolism and better water absorption levels during second season (Table 2). At square formation stage, the combination of WGCV-48 planted under 75x10 cm spacing had shown maximum transpiration rate (5.6 mol m^{-2} s^{-1}) when compared to all other combinations of genotypes and spacings. The combination of genotype NDLH-1938 under 75x10 cm had shown maximum transpiration rate at flowering stage (6.0 mol m^{-2} s^{-1}) and boll development stage also (6.8 mol m^{-2} s^{-1}). Among genotypes studied, WGCV- 48 found to be performing better with respect to transpiration rate during square stage (4.8 mol m^{-2} s^{-1}) and is on par with NDLH-1938 (4.75 mol m^{-2} s^{-1}). At flowering stage and boll development stages NDLH-1938 (5.3 mol m^{-2} s^{-1} and 6.05 mol m^{-2} s^{-1} respectively) performed better among other genotypes. Among plant densities studied, 75x10 cm had shown higher transpiration rates *i.e.*, 5.15 mol m^{-2} s^{-1} at square stage, 5.65 mol m^{-2} s^{-1} at flowering stage and 6.15 mol m^{-2} s^{-1} at boll development stage. The percentage increase of transpiration rate in 75x10 cm over 60x10 cm and 45x10 cm is 8.4% and 41% respectively. Stomatal conductance would be a possible indicator for inducing drought tolerance, although a negative correlation is associated between drought resistance and stomata conductance in cotton (Khan, 2018) [6].

Stomatal conductance

The stomatal conductivity readings of cotton during second season *i.e., kharif*, 2017 showed an increase in the first crop season (Table 3). WGCV- 48 (413.5 mmol [H_2O] m^{-2} s^{-1}), was on par with NDLH-1938 (403 mmol [H_2O] m^{-2} s^{-1}) and found to have better stomatal conductance during square stage. Flowering stage and boll development stages also showed similar trend for stomatal conductance. WGCV-48, which was on par with NDLH-48 showed maximum stomatal conductance during flowering stage (634 mmol [H_2O] m^{-2} s^{-1} and 621 mmol [H_2O] m^{-2} s^{-1}) and boll development stage (583.5 mmol [H_2O] m^{-2} s^{-1} and 560 mmol [H_2O] m^{-2} s^{-1}) respectively. Among plant densities, 75x10 cm spacing had shown higher stomatal conductance rates at square stage (377.5 mmol [H_2O] m^{-2} s^{-1}), at flowering stage (604 mmol [H_2O] m^{-2} s^{-1}) and at boll development stage (626 mmol [H_2O] m^{-2} s^{-1}). Increase in stomatal conductance during square initiation stage in 75x10 cm over 60x10 cm and 45x10 cm was 9.8% and 14.9% respectively.

At square formation stage, the combination of WGCV-48 planted under 75x10 cm spacing shown maximum stomatal conductance (427.5 mmol [H_2O] m^{-2} s^{-1}) when compared to all other combinations of genotypes and spacings. The combination of genotype NDLH-1938 under 75x10 cm had shown maximum transpiration rate at flowering stage (714 mmol [H_2O] m^{-2} s^{-1}) and boll development stage also (744 mmol [H_2O] m^{-2} s^{-1}). This combination is on par with combination of NDLH-1938 planted under 75x10 cm at square stage, flowering stage and boll development stage (419 mmol [H_2O] m^{-2} s^{-1}, 699.5 mmol [H_2O] m^{-2} s^{-1} and 742.5 mmol [H_2O] m^{-2} s^{-1} respectively). Exposure to mild moisture stress stimulates stomata closure to reduce water loss by regulating transpiration. This reduces stomatal conductance and limits intercellular CO_2 concentration (Khan, 2018) [6].

SPAD meter readings

The SCMR values are good in season indicators of Nitrogen status of plant tissues. SCMR increased upto the stage of boll development in all the studied genotypes during both seasons of study (Table 4). In *kharif*, 2016 and *kharif* 2017, maximum SCMR was found by WGCV-48 at square stage (31.8, 32.7), flowering stage (40.5, 38.9) and boll development stage (42.8, 29.5). The genotypes differed significantly for SCMR values in both years of study. The difference in SCMR among the cultivars may be attributed to their genetic nature and environmental interactions. At square stage maximum SCMR values were recorded with WGCV-48 (32.3) under 75x10 cm spacing. Same trend was observed during following phenological stages. The cultivar WGCV- 48 showed maximum SCMR values under 75x10 cm during flowering stage (39.7) and also during boll development stage (36.2). Among spacings studied, maximum SCMR has been recorded in 75x10 cm during square stage (31.0), flowering stage (38.4) and boll development stage (34.7). Minimum values were recorded in 45x10 cm during square stage (27.2), flowering stage (34.0) and boll development stage (32.9). Per cent decrease in maximum SCMR at boll development stage for 75x10 cm over 60x10 cm and 45x10 cm were 3.5, 6.0 % and 11.8, 4.4 % during *kharif*, 2016 and 2017 respectively. Birader, 2013 reported higher SPAD meter readings of cotton at 75 DAS grown under 60x10 cm spacing (41.5) as compared to 45x10 (35.4) and 45x 15 cm spacing (37.9). Ronselem, (2012) [8], reported that Mepiquat chloride increased chlorophyll contents (SPAD) in cotton leaves.

Seed cotton yield (kg ha^{-1})

Significantly higher seed cotton yield was recorded in 75x10 cm spacing (1639 kg ha^{-1}) over 60x10 cm (1547 kg ha^{-1}) and 45x10 cm (1366 kg ha^{-1}). The percent rise of seed cotton yield in 75x10 cm over 60x10 cm and 45x10 cm is 6% and 19.9 % respectively. WGCV-48 (1908 kg ha^{-1}) recorded maximum seed cotton yield and was significantly superior than NDLH-1938 (1617 kg ha^{-1}). Seed cotton yield in any cultivar is result of cumulative product of boll weight and number of bolls per plant. The better yield in WGCV-48 over other studied cultivars is ascribed to more number of bolls per each plant and also heavier bolls. Ali *et al*, 2011 reported maximum seed cotton yield (2486.2 kg ha^{-1}) in early sown crop under close plant spacing of 15 cm and minimum (1762.3 kg ha^{-1}) in wide plant spacing of 45 cm. Jahedi *et al.*, (2013) [5] similarly reported that sympodial branches, individual boll weight and number of bolls per plant were reduced under narrow row spacing (30cm row spacing). Lint yield was found equal or more than in 70 cm row spacing. Row spacing found to have no role yield quality. Thus a plant type with high yield potential, short stature in addition transgenes presence and better fibre properties is preferred in development of ideotype.

Table 1: Photosynthetic rate (μ mol CO_2 m^{-2} s^{-1}) of cotton genotypes as influenced by different spacings in two seasons of crop growth and pooled.

		Square Stage			Flowering Stage			Boll Development Stage		
Genotype	**Spacing**	**Season 1**	**Season 2**	**Pooled**	**Season 1**	**Season 2**	**Pooled**	**Season 1**	**Season 2**	**Pooled**
WGCV-48	75 x 10	11.3	12.6	12.0	18.6	20.0	19.3	26.3	28.9	27.6
	60 x 10	11.3	11.1	11.2	16.4	18.3	17.4	24.9	25.9	25.4
	45 x 10	10.4	10.2	10.3	14.8	15.8	15.3	24.2	25.5	24.9
NDLH-1938	75 x 10	10.5	10.2	10.4	16.6	17.3	17.0	24.4	26.5	25.5
	60 x 10	10.6	9.1	9.9	14.7	16.4	15.6	22.1	23.6	22.9
	45 x 10	9.2	8.6	8.9	13.6	14.9	14.3	23.5	23.4	23.5
H-4492859	75 x 10	10.0	8.4	9.2	17.4	16.5	17.0	25.0	25.3	25.2
	60 x 10	9.1	7.7	8.4	15.4	16.5	16.0	22.6	23.0	22.8
	45 x 10	8.9	8.2	8.6	13.4	15.9	14.7	22.2	21.8	22.0
Suraj	75 x 10	10.8	9.6	10.2	16.3	16.1	16.2	25.6	27.3	26.5
	60 x 10	10.1	8.5	9.3	15.1	15.6	15.4	23.2	24.6	23.9
	45 x 10	8.3	8.2	8.3	13.7	13.2	13.5	23.1	23.5	23.3
ADB-39	75 x 10	9.3	10.0	9.7	15.6	16.5	16.1	23.7	25.4	24.6
	60 x 10	9.0	9.5	9.3	13.6	15.7	14.7	22.9	25.1	24.0
	45 x 10	7.6	8.5	8.1	13.0	12.6	12.8	22.2	24.0	23.1
Anjali	75 x 10	9.1	8.8	9.0	15.7	15.6	15.7	23.8	25.3	24.6
	60 x 10	8.4	8.2	8.3	13.6	15.1	14.4	21.8	23.2	22.5
	45 x 10	7.4	7.9	7.7	12.8	13.7	13.3	21.4	21.7	21.6
Grand Mean		9.5	9.2	9.4	15.0	15.9	15.5	23.5	24.7	24.1
C.D.(0.05)										
S at same G		1.7	1.2	1.1	1.8	1.8	1.3	2.0	2.7	2.0
G at same S		1.3	1.2	0.9	1.4	1.8	1.1	1.7	2.0	1.5
Means of Genotypes										
WGCV-48		11.0	11.3	11.2	16.6	18.0	17.3	25.1	26.8	26.0
NDLH-1938		10.1	9.3	9.7	15.0	16.2	15.6	23.3	24.5	23.9
H-4492859		9.3	8.1	8.7	15.4	16.3	15.9	23.2	23.4	23.3
Suraj		9.7	8.7	9.2	15.0	14.9	15.0	24.0	25.1	24.6
ADB -39		8.6	9.3	9.0	14.1	14.9	14.5	23.0	24.8	23.9
Anjali		8.3	8.3	8.3	14.0	14.8	14.4	22.3	23.4	22.9
C.D.(0.05)		1.3	0.5	0.8	1.4	1.0	1.0	1.4	2.2	1.5
Means of Spacings										
75 x 10 cm		10.2	9.9	10.1	16.7	17.0	16.8	24.8	26.4	25.6
60 x 10 cm		9.8	9.0	9.4	14.8	16.3	15.5	22.9	22.3	23.6
45 x 10 cm		8.6	8.6	8.6	13.6	14.3	14.0	22.8	23.3	23.0
C.D.(0.05)		0.5	0.8	0.4	0.6	0.7	0.4	0.7	0.8	0.6
C.V.(%)		13.4	7.9	7.8	8.9	6.1	6.2	5.5	8.4	6.0

Table 2: The Transpiration rate (mol m^{-2} s^{-1}) of cotton genotypes as influenced by different spacings in two seasons of crop growth and pooled.

		Square Stage			Flowering Stage			Boll Development Stage		
Genotype	**Spacing**	**Season 1**	**Season 2**	**Pooled**	**Season 1**	**Season 2**	**Pooled**	**Season 1**	**Season 2**	**Pooled**
WGCV-48	75 x 10	5.4	5.7	5.6	5.4	6.5	6.0	6.4	7.0	6.7
	60 x 10	4.9	5.2	5.1	5.3	5.8	5.6	6.0	6.4	6.2
	45 x 10	3.9	3.9	3.9	4.2	4.3	4.3	5.1	5.2	5.2
NDLH-1938	75 x 10	5.2	5.5	5.4	5.6	6.3	6.0	6.5	7.1	6.8
	60 x 10	4.8	5.1	5.0	5.3	5.9	5.6	6.1	6.4	6.3
	45 x 10	4.0	4.0	4.0	4.3	4.3	4.3	4.9	5.1	5.0
H-4492859	75 x 10	5.2	5.3	5.3	5.4	6.1	5.8	6.1	6.3	6.2
	60 x 10	4.5	5.1	4.8	5.1	5.1	5.1	5.7	6.0	5.9
	45 x 10	4.0	3.8	3.9	4.2	4.3	4.3	4.7	4.5	4.6
Suraj	75 x 10	4.9	5.1	5.0	5.2	5.8	5.5	5.8	6.2	6.0
	60 x 10	4.4	4.8	4.6	4.7	4.6	4.7	5.6	6.1	5.9
	45 x 10	3.4	3.3	3.4	3.6	4.2	3.9	4.1	4.5	4.3
ADB-39	75 x 10	4.6	5.1	4.9	5.0	5.7	5.4	5.9	5.5	5.7
	60 x 10	4.1	4.8	4.5	4.7	4.7	4.7	5.5	5.2	5.4
	45 x 10	3.5	3.2	3.4	3.7	3.7	3.7	4.4	4.0	4.2
Anjali	75 x 10	4.8	5.2	5.0	5.1	5.5	5.3	5.6	5.7	5.7
	60 x 10	4.2	4.8	4.5	4.6	4.3	4.5	5.4	5.3	5.4
	45 x 10	3.3	3.3	3.3	3.6	3.9	3.8	4.3	4.1	4.2
Grand Mean		4.4	4.6	4.5	4.7	5.1	4.9	5.5	5.6	5.5
C.D.(0.05)										
S at same G		0.47	0.17	0.22	0.32	0.61	0.34	0.26	0.90	0.45
G at same S		0.43	0.19	0.22	0.32	0.50	0.32	0.23	0.90	0.47
Means of Genotypes										

WGCV-48	4.7	4.9	4.8	5	5.5	5.25	5.8	6.2	6
NDLH-1938	4.6	4.9	4.75	5.1	5.5	5.3	5.9	6.2	6.1
H-4492859	4.6	4.7	4.65	4.9	5.2	5.05	5.5	5.6	5.6
Suraj	4.2	4.4	4.3	4.5	4.8	4.65	5.2	5.6	5.4
ADB -39	4.1	4.4	4.25	4.5	4.7	4.6	5.2	4.9	5.1
Anjali	4.1	4.4	4.25	4.5	4.6	4.55	5.1	5	5.1
C.D.(0.05)	0.32	0.08	0.13	0.18	0.45	0.21	0.19	0.52	0.24
Means of Spacings									
75 x 10 cm	5	5.3	5.15	5.3	6	5.65	6	6.3	6.15
60 x 10 cm	4.5	5	4.75	5	5.1	5.05	5.7	5.9	5.8
45 x 10 cm	3.7	3.6	3.65	3.9	4.1	4	4.6	4.6	4.6
C.D.(0.05)	0.18	0.08	0.09	0.13	0.21	0.13	0.09	0.37	0.19
C.V.(%)	5.84	2.44	2.86	4.02	5.89	3.91	2.50	9.53	5.02

Table 3: The Stomatal Conductivity (g_s) (mmol [H_2O] m^{-2} s^{-1}) of cotton genotypes as influenced by different spacings in two seasons of crop growth and pooled.

		Square Stage			Flowering Stage			Boll Development Stage		
Genotype	**Spacing**	**Season 1**	**Season 2**	**Pooled**	**Season 1**	**Season 2**	**Pooled**	**Season 1**	**Season 2**	**Pooled**
WGCV-48	75 x 10	398	457	428	667	761	714	703	785	744
	60 x 10	410	417	414	624	688	656	581	620	601
	45 x 10	396	401	399	524	539	532	402	411	407
NDLH-1938	75 x 10	392	446	419	652	747	700	713	772	743
	60 x 10	398	412	405	615	693	654	532	568	550
	45 x 10	377	394	386	498	521	510	378	397	388
H-4492859	75 x 10	387	444	416	617	713	665	665	738	702
	60 x 10	374	367	371	578	355	467	501	535	518
	45 x 10	376	354	365	453	319	386	362	383	373
Suraj	75 x 10	318	367	343	494	554	524	637	705	671
	60 x 10	336	346	341	511	569	540	397	423	410
	45 x 10	380	246	313	309	314	312	365	385	375
ADB-39	75 x 10	316	359	338	480	538	509	385	425	405
	60 x 10	246	257	252	375	413	394	367	389	378
	45 x 10	279	235	257	328	339	334	351	362	357
Anjali	75 x 10	305	338	322	477	551	514	468	518	493
	60 x 10	277	285	281	429	480	455	385	415	400
	45 x 10	279	226	253	295	304	300	350	359	355
Grand Mean		347	347	353	350	496	522	509	475	511
C.D.(0.05)										
S at same G		69.1	47.2	39.4	107.2	92.8	71.4	67.7	67.8	41.9
G at same S		59.6	48.5	38.3	53.2	95.5	55.9	70.4	63.3	33.9
Means of Genotypes										
WGCV-48		402	425	414	605	663	634	562	605	584
NDLH-1938		389	417	403	588	654	621	541	579	560
H-4492859		379	388	384	549	462	506	509	552	531
Suraj		345	319	332	438	479	459	466	504	485
ADB -39		280	284	282	394	430	412	368	392	380
Anjali		287	283	285	400	445	423	401	430	416
C.D.(0.05)		49.1	25.8	24.0	98.0	50.5	55.0	35.9	44.0	31.4
Means of Spacings										
75 x 10 cm		353	402	377.5	564	644	604	595	657	626
60 x 10 cm		340	347	343.5	522	533	527.5	460	497	478.5
45 x 10 cm		348	309	328.5	401	389	395	368	383	375.5
C.D.(0.05)		24.3	19.8	15.6	21.7	39.0	22.8	28.7	25.8	13.9
C.V.(%)		10.19	8.15	6.49	6.36	10.86	6.52	8.80	7.36	4.09

Table 4: SPAD Chlorophyll Meter Readings (SCMR) of cotton genotypes as influenced by different spacings in two seasons of crop growth and pooled.

		Square Stage			Flowering Stage			Boll Development Stage		
Genotype	**Spacing**	**Season 1**	**Season 2**	**Pooled**	**Season 1**	**Season 2**	**Pooled**	**Season 1**	**Season 2**	**Pooled**
WGCV-48	75 x 10	35.6	36.6	36.1	41.4	42.1	41.8	45.9	34.0	40.0
	60 x 10	32.5	29.8	31.2	40.9	39.4	40.2	41.6	27.1	34.4
	45 x 10	27.4	31.7	29.6	39.3	35.2	37.3	40.9	27.4	34.2
NDLH-1938	75 x 10	36.6	29.0	32.8	39.3	38.5	38.9	41.7	26.4	34.1
	60 x 10	34.0	31.6	32.8	38.4	36.8	37.6	40.3	26.6	33.5
	45 x 10	28.5	25.8	27.2	37.7	29.5	33.6	38.8	25.9	32.4
H-4492859	75 x 10	33.4	27.5	30.5	37.7	38.5	38.1	39.2	30.2	34.7
	60 x 10	31.8	34.5	33.2	37.7	35.9	36.8	38.9	27.0	33.0

	45 x 10	27.1	31.7	29.4	34.7	36.3	35.5	36.5	28.7	32.6
Suraj	75 x 10	33.5	36.0	34.8	38.0	42.7	40.4	38.2	31.8	35.0
	60 x 10	32.1	33.3	32.7	38.6	40.3	39.5	37.5	28.4	33.0
	45 x 10	27.3	30.6	29.0	33.9	37.5	35.7	37.1	30.2	33.7
ADB-39	75 x 10	21.1	25.4	23.3	38.4	32.3	35.4	37.5	25.5	31.5
	60 x 10	18.7	38.2	28.5	34.5	29.0	31.8	36.6	21.6	29.1
	45 x 10	16.7	29.5	23.1	33.5	26.0	29.8	35.0	26.2	30.6
Anjali	75 x 10	24.1	32.5	28.3	35.2	37.1	36.2	37.0	28.8	32.9
	60 x 10	21.2	33.7	27.5	34.2	36.4	35.3	36.1	26.4	31.3
	45 x 10	18.5	31.6	25.1	32.0	32.0	32.0	36.8	31.0	33.9
Grand Mean		27.8	31.6	29.7	37.0	35.9	36.4	38.6	28.0	33.3
C.D.(0.05)										
S at same G		4.0	6.5	3.8	4.1	8.1	4.6	7.2	3.1	3.9
G at same S		3.8	5.9	3.1	3.7	6.5	3.4	6.5	3.6	3.5
Means of Genotypes										
WGCV-48		31.8	32.7	32.3	40.5	38.9	39.7	42.8	29.5	36.2
NDLH-1938		33.0	28.8	30.9	38.4	34.9	36.7	40.3	26.3	33.3
H-4492859		30.8	31.3	31.1	36.7	36.9	36.8	38.2	28.6	33.4
Suraj		31.0	33.3	32.2	36.8	40.2	38.5	37.6	30.1	33.9
ADB -39		18.8	31.0	24.9	35.5	29.1	32.3	36.4	24.4	30.4
Anjali		21.3	32.6	27.0	33.8	35.2	34.5	36.6	28.8	32.7
C.D.(0.05)		2.5	4.3	2.8	2.8	6.1	3.7	4.9	1.1	2.6
Means of Spacings										
75 x 10 cm		30.7	31.2	31.0	38.3	38.5	38.4	39.9	29.5	34.7
60 x 10 cm		28.4	33.5	31.0	37.3	36.3	36.8	38.5	26.2	32.4
45 x 10 cm		24.2	30.2	27.2	35.2	32.8	34.0	37.5	28.2	32.9
C.D.(0.05)		1.6	2.4	1.3	1.5	2.6	1.4	2.7	1.5	1.4
C.V.(%)		8.5	13.1	8.9	7.2	16.3	9.6	12.1	3.8	7.5

Table 5: Seed Cotton Yield of cotton genotypes as influenced by different spacings in two seasons of crop growth and pooled.

Seed Cotton Yield (kg ha^{-1})				
Genotype	**Spacing**	**Season 1**	**Season 2**	**Pooled**
WGCV-48	75 x 10	2169	2103	2136
	60 x 10	1918	1928	1923
	45 x 10	1761	1566	1663
NDLH-1938	75 x 10	2016	1397	1707
	60 x 10	1738	1456	1597
	45 x 10	1519	1577	1548
H-4492859	75 x 10	1921	1481	1701
	60 x 10	1602	1288	1445
	45 x 10	1271	1333	1302
Suraj	75 x 10	1784	1305	1544
	60 x 10	1801	1315	1558
	45 x 10	1471	1399	1435
ADB-39	75 x 10	1728	1001	1365
	60 x 10	1412	1570	1491
	45 x 10	1113	1239	1176
Anjali	75 x 10	1650	1118	1384
	60 x 10	1362	1175	1268
	45 x 10	1058	1088	1073
Grand Mean		1627	1408	1518
C.D.(0.05)				
S at same G (CD4)		216.3	261	176
G at same S (CD3)		262.3	261	192
Means of Genotypes				
WGCV-48		1949	1866	1908
NDLH-1938		1758	1477	1617
H-4492859		1598	1368	1483
Suraj		1685	1340	1513
ADB -39		1418	1270	1344
Anjali		1356	1127	1242
C.D.(0.05)		30.5	148.5	80.2
Means of Spacings				
75 x 10 cm		1878	1401	1639
60 x 10 cm		1634	1456	1547
45 x 10 cm		1365	1367	1366
C.D.(0.05)		107.0	106.8	78.3
C.V.(%)		9.6	11.03	7.51

Conclusion

Better attenuation of light, better competing ability of plants planted in system of 75x10 cm over 60x10 cm and 45x10 cm systems. Imposing of intra specific competition could enhance the abiotic stress tolerance levels in Cotton (*Gossypium hirsutum* L.).

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