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Field Screening of Cotton Genotypes for Drought Tolerance on the Basis of Yield and Fibre Traits

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Abstract: The yield and fibre traits of cotton are adversely influenced by moisture stress. Thus, it is great issue for cotton physiologists and breeders to develop water stress tolerable genotypes. In current research, 12 cultivars such as CRIS-134, CRIS-342, CIM-499, Sadori, CIM-506, Chandi, BH-160, Sindh-1, NIAB-78, CIM-496, CIM-534 and Bt-cotton (Australian origin) were screened for water stress tolerance with four replications in factorial design in Pakistan during 2010. Water stress caused significant reduction in all yield as well fibre traits. The genotypes also differed significantly for yield and fibre quality traits studied. The treatments x genotypes interactions were significant indicating that genotypes responded variably over stress environments suggesting that plant breeders can select the best performing genotypes for moisture deficit environments. Among genotypes screened, Sadori, CRIS-134,Chandi, CRIS-342,CIM-506 and Sindh-1 showed good performance due to minimum decline under stress conditions for majority of the traits. Hence, these cotton genotypes were identified as drought tolerant and can be further utilized in breeding programmes to develop new drought tolerant breeding material.

Keywords: Screening, Drought, Yield And Fibre Traits, Cotton Genotypes, *Gossypium hirsutum* L.

1. INTRODUCTION

Drought stress is considered as the most limiting factor that reduces crop productivity all over the world. Among the abiotic stresses, drought adversely affects the plant growth and development, consequently the yield (Reddy *et al*., 2004; Basal *et al*., 2009; Makbul *et al*., 2011). Inadequate soil moisture during both seedling and reproductive stages such as square and fruit formation and that can reduce plant growth, number of fruiting branches, development of bolls and seeds, number of bolls formed, seed cotton yield and fibre traits (Yazar *et al*., 2002; Pettigrew, 2004a; Aujla *et al*., 2005; Sahito *et al*., 2015). The key to successful screening technique against drought stress is the aptitude to screen huge number of plants in the shortest time possible. Thus, effective screening methods will be worth to evaluate performance of genotypes at critical developmental stages (Johnson, 1980). The screening method must be incorporated into plant breeding programs so as to achieve the meaningful genetic improvement. Plant yield and physiological traits are now being added into the breeding programs to use them as selection criteria in developing ideotype plants for water stress conditions (De-Ronde *et al*., 2000). Drought stress provoke the expression of stress-related transcription factors and genes, such as abscisic acid or mitogen-activated protein kinases expressing genes, which trigger different stress associated pathways to persuade tolerance in crop species (Abid *et al*., 2017). Various morphological, physiological and yield characters are being used to measure drought tolerance when they are correlated with each other. Several studies have shown as how cotton yield and fibre traits are badly influenced by water deficiency. Seed cotton yield essentially depends upon the formation and maintenance of such bolls and these attributes severely decline by drought conditions Under water stress, reduction in seed cotton yield is largely due to the decline in boll formation and boll weight ((Guinn and Mauney, 1984;Mert, 2005; Basal *et al*., 2009). Drought conditions also affect fib revalue in various ways; particularly during the fibre maturation thus causes decrease in fibre size and induces immaturity in fibre (Mert, 2005; Ritchie *et al*., 2004). Some earlier researchers observed that sufficient amount of genetic variation for water stress exists in cotton due to the reason cotton is derived from those environments which frequently experience water shortages (Pettigrew and Meredith, 1994; Lacape *et al*., 1998). Thus, selection for moisture stress resistance remained great concern to cotton breeders. More than 30 traits which include morphological and physiological have been adopted to select the plants which prove moisture stress tolerance. Nonetheless, no any character has been reliably identified which is persistently associated with moisture stress tolerance (Loka *et al*., 2011). The complexity in detection of morpho-physiological traits as a dependable marker for improving seed cotton yield in water stress environments revealed that yield performance obtained from different ecological conditions may serve as reliable criterion to select drought tolerant plants (Voltas *et al*., 2005).

2. MATERIALSANDMETHODS

The present experiment was laid-out in the experimental farm of Plant Breeding and Genetics at Sindh Agriculture University Tandojam, Pakistan in

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2010. Twelve most popular cotton cultivars viz. CRIS-134, CRIS-342, CIM-499, Sadori, CIM-506, Chandi, BH-160, Sindh-1, NIAB-78, CIM-496, CIM-534 and Bt-cotton(Australian origin) with most diversified traits and source were assessed. The trial was conducted in factorial arrangement with two irrigation regimes, optimum and stress at reproductive stage with four repeats. The water treatments were regarded as the main factor whereas cultivars as sub-factor. All agricultural inputs and practices like spraying, fertilization, weeding, irrigation and cotton production technology were adopted as recommended for the cotton crop. The data were collected from ten tagged plants in each replication per genotypes. Six irrigations in non-stress treatment were applied according to the crop requirement whereas in water stress treatment, the water stress was imposed at reproductive stage from 75 till 110 days of planting which is called as stress at reproductive phase. The observations were recorded on boll opening at 110 days after planting, plant height (cm), sympodial branches plant^{-1}, bolls plant^{-1}, boll weight (g), lint %, staple length (mm), seed cotton yield in kg per hectare and 100-seed weight g, staple length (mm) and fibre strength (tppsi). The experiment was conducted in loamy and sandy loam soil. The filed capacity ranged from 20.2 to 27.3% while wilting level ranged from 7.1 to 9.8 % based soil dry weight. No rain fall was observed during experimentation. The data were analyzed according to procedures developed by Gomez (1984) by using factorial model and LSD at 5% probability was applied to compare the means and calculated with Statistix software, 8.1 editions.

3. RESULTSAND DISCUSSION

Analysis of variance (**Table 1**) revealed that water stress resulted momentous decline in stem tallness, sympodia numbers per plant ,total bolls formed per plant, boll size, yield per plant, lint % seed index, fibrespan, fibre strength and seed cotton yield in kg per hectare. Noteworthy variability was also observed amongst the cultivars for yields and yield related traits. These types of results could help cotton breeders to choose the water stress affording varieties based on several yield related traits (Volkan *et al*., 2015). These interactions could help cotton breeders to select the promising cotton varieties based on one or more reliable drought tolerant indicators and put them in a breeding programme to develop new drought tolerant breeding material. Present results are in accordance with those of Soomro *et al*. (2011) who also observed differences in cultivar performance assessed in optimum and under water stress conditions.

Mean performance of cotton genotypes under water stress conditions

Bolls opened at 110 days after planting: The reaction of water stress on boll opening was that the bolls opened early and rapidly against normal treatment. The varieties performed variably for boll opening at 110 days as presented in **(Table 2)**. The higher numbers of bolls were opened under water stress by varieties CIM-499 (24.75), Bt-cotton (24.25), BH-160 (22.75) and Chandi (21.25). However, other genotypes, CRIS-134 (22.00) and CIM-506 (20.75) were relatively less affected by water stress and bolls opened with slight decrease. Less opening of bolls at 110 days in latter group of genotypes indicated their tolerance to water stress. Jayalalitha *et al*. (2015) also reported that, under rain-fed conditions, Bt-cotton hybrids attained early boll opening by about 16 days and 15 days in two years as compared to irrigated conditions.

Plant height (cm): Medium taller plants in cotton remained the choice plant tallness for higher flower and boll formation. Results indicated that tallest plants were produced by BH-160 in non-stress **(Table 2**).Water stress, on an average, caused -11.51% decline in stem height, yet minimum reduction was observed in Sadori (-2.53%) followed byCRIS-134 (-7.75%), CIM-506 (-8.92%), Sindh-1 (-9.52%), CIM-534 (-9.47%) and Chandi(-11.60%). Similar results were reported by Shakoor *et al*. (2010), Soomro *et al*. (2011) and Mahmood *et al*. (2006) who observed that early water stress caused severe effect on stem tallness.

Sympodia plant^{-1}: Sympodial branches plant^{-1}is main contributing character having undeviating positive association with yield production in cotton. The maximum reductions in sympodia plant^{-1} due to water stress were observed in NIAB-78 (-21.37%), **(Table 3),** yet minimum and moderate reductions were observed in

Table 1. Analysis of variance (mean squares)for yieldand fiber characters in cotton cultivars grown in non-stress and water stress conditions

Traits	Replication (D.F.=3)	Genotypes (G) (D.F.=11)	Treatment (T) (D.F.=1)	G x T (D.F.=11)	Error (D.F.= 69)
Bolls opened at 110 days	2.97	64.05**	32.66**	17.37**	1.53
Plant height	4.76	593.46**	5969.26**	92.33**	11.50
Sympodial branches plant^{-1}	0.19	22.60**	345.04**	2.85**	0.41
Bolls plant^{-1}	0.59	236.50**	1708.59**	44.91**	0.67
Boll weight	0.05	2.02**	6.74**	0.19**	0.15
Seed cotton yield plant^{-1}	244.70	5844.20**	59021.50**	1192.60**	288.40
Lint (%)	10.40	35.01**	400.16**	8.09**	3.51
Seed index	0.23	4.12**	47.46**	0.67**	0.03
Staple length	0.20	7.01**	184.26**	4.05**	0.50
Fiber strength	1.59	149.80	625.26**	6.67**	0.79
Seed cotton yield (kg ha^{-1})	10392.70	619037.00**	24167822.50**	134883.00**	4517.35

** = P≤ 0.01 probability level.

CRIS-134 (-7.75%), followed by Sadori (-9.36%), Sindh-1 (-9.52%), Chandi (-11.60%), CRIS-342 (-12.65%) and CIM-534(-14.04%).On an average, water stress however caused-13.83% sympodial reductions due to drought stress (**Table 3**). These results are in consonance with those obtained by Soomro *et al*. (2011) and Baloch *et al*. (2011) who stated that sympodia number per plant were rigorously reduced due to drought stress. Jayalalitha *et al*. (2015) also reported that cotton hybrids under rain-fed conditions reduced their sympodia by 32 and 34% in mean number per plant at harvest against optimum conditions in two years of experimentation.

Bolls plant^{-1}: The number of fruits per plant established high relationship with yield production per plant. Highest fruit formation per plant produces more seed cotton yield. Because of scarcity of canal water, fruit abscission in cotton increases, thus yield production declines. On an average, maximum reduction in bolls plant^{-1} due to water stress was observed in Bt-cotton (-40.61%) (**Table 3**) followed by BH-160 (-29.70%), yet minimum reduction was recorded in Sadori (-7.32%) followed by CRIS-134 (-8.26%), CIM-506 (-9.74%), Chandi (-12.50%), CIM-534(-11.63%) and CIM-496 (-11.91%), thus these cultivars may be grown in water stress conditions so as to develop breeding material which can survive water deficit conditions. Wanga *et al*. (2016) reported that drought not only has reduced lint yield by 31 to 35 (under stress) and 57 to 60% (in non-stress) but also produced fewer and smaller bolls as compared to well-watered plants. Such findings are also in consonance with Bentol-Hoda *et al*. (2015).

Boll weight (g): Bigger boll sizes are expected to produce higher yield production, but it is experienced that in cotton, medium with more bollsplant^{-1}produce highest production. It is mostly noted that drought conditions adversely affects the boll weight. The highest declinein boll size (-37.74%) was recorded in Bt-cotton (**Table 4**), while minimum reduction in boll weight was noted in water stress tolerant group of genotypes like CIM-506 (-5.07%) followed by CRIS-134 (-6.67%), CIM-534 (-6.44%), Sadori (-7.58%), Chandi (-13.54%) and Sindh-1 (-14.05%). In drought conditions, boll size reduced considerably which suggested that cotton plant is highly susceptible to drought conditions, however varieties which recorded minimum reductions in boll weight are better choice to develop water stress breeding material. Similar to current findings, Plaut *et al*. (1992) and Soomro *et al*. (2011) stated that inadequate supply of moisture at boll development stage resulted in extensively lower production.

Seed cotton yield plant^{-1}(g): Seed cotton yield mostly depends upon sympodia numbers, fruit formation and boll size and these characters unswervingly add their contribution for getting more yields per plant and consequently on per ha^{-1} basis. Confined water supply poses considerable impact on yield production plant^{-1} (**Table 4**). On an average, water stress caused a maximum decline of -31.25%in seed cotton yield plant^{-1} yet, minimum reduction was observed in CIM-496 (-8.04%) followed by CIM-534 (-19.48%), Sadori (-17.40%), CRIS-134 (-16.12%), Chandi (-23.77%). Results further revealed that, cultivars CIM-496, CIM-534, Sadori, CRIS-134 and Chandi produced highest seed cotton yield per plantin water stress conditions, therefore these cultivars can be planted in drought conditions and selection may be carried-out to develop water stress tolerant genotypes.

Table 2. Mean performance for days to boll opening at 110 days and plant height of cotton genotypes grown in water stress conditions

Cultivars	Bolls opened at 110 DAP**		RID*(%)	Plant height (cm)		RD*(%)
	Non-stress	Water stress		Non-stress	Water stress	
CRIS-134	22.75	22.00	-3.30	138.75	128.00	-7.75
CRIS-342	14.50	12.75	-12.07	122.50	107.00	-12.65
Sadori	18.00	17.25	-4.17	128.25	125.00	-2.53
Chandi	17.75	21.25	19.72	125.00	110.50	-11.60
Sindh-1	17.00	16.00	-5.88	139.25	126.00	-9.52
NIAB-78	18.75	19.50	4.00	146.25	115.00	-21.37
CIM-496	16.25	15.00	-7.69	133.25	113.00	-15.20
CIM-499	22.00	24.75	12.50	135.75	120.00	-11.60
CIM-506	21.00	20.75	-1.19	134.50	122.50	-8.92
CIM-534	20.00	19.75	-1.25	142.50	129.00	-9.47
BH-160	16.00	22.75	42.19	156.75	139.25	-11.16
Bt-cotton	18.00	24.25	34.72	141.75	120.00	-15.34
Mean	18.50	19.67	6.32	137.04	121.27	-11.51
LSD (5%) Genotypes (G)	1.23			3.38		
Treatment (T)	0.50			1.38		
G x T	1.74			4.78		

*RID = Relative increase or decrease due to water stress, DAP** = days after planting.

Table 3.Mean performance for sympodial branches plant^{-1} and bolls plant^{-1} of cotton genotypes grown water stress conditions

Cultivars	Sympodial branches plant^{-1}		RD*(%)	Bolls plant^{-1}		RD*(%)
	Non-stress	Water stress		Non-stress	Water stress	
CRIS-134	27.75	25.60	-7.75	54.50	50.00	-8.26
CRIS-342	24.50	21.40	-12.65	41.00	31.75	-22.56
Sadori	25.65	23.25	-9.36	51.25	47.50	-7.32
Chandi	25.00	22.10	-11.60	40.00	35.00	-12.50
Sindh-1	27.85	25.20	-9.52	50.00	38.00	-24.00
NIAB-78	29.25	23.00	-21.37	46.00	38.50	-16.30
CIM-496	26.65	22.60	-15.20	46.00	40.75	-11.41
CIM-499	27.15	23.00	-15.29	41.00	30.00	-26.83
CIM-506	26.90	22.00	-18.22	48.75	44.00	-9.74
CIM-534	28.50	24.50	-14.04	43.00	38.00	-11.63
BH-160	31.35	27.00	-13.88	41.25	29.00	-29.70
Bt-cotton	28.35	23.75	-16.23	49.25	29.25	-40.61
Mean	27.41	23.62	-13.83	46.00	37.65	-18.15
LSD(5%) Genotypes (G)	0.642			0.817		
Treatment (T)	0.262			0.334		
G x T	0.909			1.158		

*RD = Relative decrease due to water stress.

Table 4.Mean performance for boll weight and seed cotton yield plant^{-1} of cotton genotypes grown under non-stress and water stress conditions

Genotypes	Boll weight (g)		RD*(%	Seed cotton yield plant^{-1} (g)		RD*(%)
	Non-stress	Water stress		Non-stress	Water stress	
CRIS-134	3.75	3.50	-6.67	204.50	171.53	-16.12
CRIS-342	3.11	2.38	-23.47	162.48	75.69	-53.42
Sadori	3.56	3.29	-7.58	189.06	156.16	-17.40
Chandi	3.25	2.81	-13.54	153.56	117.06	-23.77
Sindh-1	3.06	2.63	-14.05	152.94	99.88	-34.69
NIAB-78	2.75	2.13	-22.55	137.25	81.88	-40.34
CIM-496	4.23	3.74	-11.58	115.06	105.81	-8.04
CIM-499	3.38	2.88	-14.79	138.44	86.25	-37.70
CIM-506	3.75	3.56	-5.07	183.00	138.13	-24.52
CIM-534	3.88	3.63	-6.44	157.88	127.13	-19.48
BH-160	3.81	2.81	-26.25	157.50	93.38	-40.71
Bt-cotton	3.10	1.93	-37.74	152.60	56.30	-63.11
Mean	3.47	2.94	-15.27	158.69	109.10	-31.25
LSD (5%) Genotypes (G)	0.38			16.93		
Treatment (T)	0.15			6.91		
G x T	0.54			23.95		

*RD = Relative decrease due to water stress.

Present findings are in agreement with those reported by Karademir *et al*. (2011) and Baloch *et al.* (2011) who also observed significant differences among genotypes grown in water and non-stress for seed cotton yield. The decrease by 49% in seed cotton yield was reported from two year research.

Ginning out turn%: Cotton lint% is multigenic character thatis adversely influenced by environmental factors. It depends primarily on lint weight which has a direct effect on lint yield. Lint yield in cotton depends on many factors such as genotype, environment and management practices. These factors individual or in combination affect seed cotton yield (Romagosa and Fox, 1993). Even though cotton is likely to adapt periodic drought episodes, yet optimum production of lint yield requires between 2,158 and 3,906 m^3 of water in each growing season, depending on local cultivation practices and meteorological data (McWilliams, 2003). On an average, water stress caused a decline of -10.71% in ginning outturn, nonetheless minimum reductions was observed in genotypes Sadori (-4.83%) followed by

CRIS-134 (-5.85%) and other genotypes like Chandi, CIM-506 and CIM-534 showed relatively higher reductions in lint% due to water stress (**Table 5**). Comparable to our findings, water stress imposed significant declining effect on lint% as observed by Mahmood *et al*. (2006).

Seed index (g): The average seed index in non-stress was 7.79g, while in stress conditions was 6.38g, thus on average water stress caused -18.10% reduction in seed index (**Table 5**). Nevertheless, the little decline in seed index was observed in genotypes Chandi (-12.69%) followed by Sindh-1 (-12.52%), Sadori, (-13.24%), CRIS-134(-13.67%) and CRIS-342 (-15.44%) being the stress tolerant. However maximum seed index in non-stress (9.18g) was recorded in BH-160. Soomro *et al*. (2011) also revealed that seed index decreased due to water stress.

Staple length (mm): From our correlation studies (not shown here),results revealed that staple length was positively correlated with only lint%, while its correlation with other traits was non-significant. It could be inferred from the present results that significant improvement could be made in improving staple length along with lint% without causing an adverse impact on other important traits. These types of results are quite encouraging in cotton breeding. Khan and Azhar (2000) conducted correlation studies in cotton. They observed positive association of yield with staple length and also with bolls plant^{-1}. On an average, water stress caused a decline in staple length of-10.07% (**Table 6**), yet minimum declines were recorded in CRIS-134 (-1.89%), Sadori, (-5.36%), CIM-499 (-5.56%), Sindh-1 (-7.41%).However longest fibre length measuring 29.75mm in control was recorded from BH-160 (**Table 6**). Some researchers like Pettigrew (2004b), Osborne and Banks (2006), Mahmood *et al*., (2006) and Sohail *et al*., (2016)also noted that drought caused negative impact on staple elongation, while others observed that drought stress showed no effect on fiber elongation (Luz *et al*., 1997). These conflicting findings may be attributable to differences in cultivars and year of evaluation.

Fibre strength (tppsi): Cotton fiber quality is defined by the physical properties which is related to its spin-ability into yarn and contributes to textile usage (Chee *et al*., 2005). Among the quality traits, the most important properties are those associated with the length, strength and fineness (micronaire) of the fiber (Poehlman and Sleeper, 1995). Fiber strength (g tex^{-1}) is an important trait in determining yarn spin-ability, because weak fiber (low strength) is difficult to handle during manufacturing process (Saleem *et al*., 2010). On an average, genotypes performed variably for this trait and recorded a maximum fibre strength of 107.0tpssi by CIM-506, however under stress, it reduced to a minimum strength of 90.0 tpssi (**Table-6**). The maximum reduction nevertheless was recorded as -8.74% by CIM-499, yet some genotypes performed well and minimum decline was recorded in Sindh-1 (-2.41%) Chandi, (-3.94%) and CRIS-134 (-3.57%). Similar results were reported by Osborne and Banks (2006) and Imran *et al*. (2016). Killi *et al*. (2005) also stated fiber properties of cotton may be affected by temperature, humidity and soil moisture. However, Pettigrew (2004b) noted that fiber quality response to irrigation was inconsistent yet irrigation had no effect on fiber strength.

Seed cotton yield (kg ha^{-1}): Seed cotton yield ha^{-1} actually depends upon seed cotton yield plant^{-1}. It was also affected by water stress and maximum decline in seed cotton yield was recorded as -1600kg ha^{-1} in Bt-cotton **(Table 7**), yet the minimum decline of -18.47% was observed in CIM-496 followed by CIM-499 (-25.04%), (CRIS-342 (-22.22%) and Sindh-1 (-21.15%). The average reduction in yield however was -26.68%. The dropin seed cotton yield and span lengthin our results are analogous to those noted by various researchers such as Pettigrew, (2004b), Bolek (2007), Alishah and Ahmadikhah, (2009) Memon *et al*.(2014).

Table 5.Mean performance for ginning outturn% and seed index of cotton genotypes grown in water stress conditions

Genotypes	Ginning outturn (%)		RD*(%)	Seed index (g)		RD*(%)
	Non-stress	Water stress		Non-stress	Water stress	
CRIS-134	42.75	40.25	-5.85	7.68	6.63	-13.67
CRIS-342	42.00	33.00	-21.43	6.80	5.75	-15.44
Sadori	36.25	34.50	-4.83	6.95	6.03	-13.24
Chandi	40.00	34.50	-13.75	6.70	5.85	-12.69
Sindh-1	36.25	34.00	-6.21	6.95	6.08	-12.52
NIAB-78	37.25	32.00	-14.09	7.70	5.93	-22.99
CIM-496	37.50	34.00	-9.33	8.45	7.13	-15.62
CIM-499	37.75	34.00	-9.93	8.90	6.13	-31.12
CIM-506	38.00	35.00	-7.89	8.95	7.58	-15.31
CIM-534	38.25	35.25	-7.84	7.70	6.60	-14.29
BH-160	36.00	32.25	-10.42	9.18	7.25	-21.02
Bt-cotton	36.25	30.50	-15.86	7.50	5.65	-24.67
Mean	38.19	34.10	-10.71	7.79	6.38	-18.10
LSD(5%) Genotypes (G)	1.86			0.18		
Treatment (T)	0.76			0.07		
G x T	2.64			0.25		

*RD = Relative decrease due to water stress.

Table 6.Mean performance for staple length and fibre strength of cotton genotypes grown under non-stress and water stress conditions

Genotypes	Staple length (mm)		RD*(%)	Fibre strength (tppsi)		RD*(%)
	Non-stress	Water stress		Non-stress	Water stress	
CRIS-134	26.50	26.00	-1.89	105.00	101.25	-3.57
CRIS-342	26.00	23.00	-11.54	96.50	92.50	-4.15
Sadori	28.00	26.50	-5.36	101.50	94.00	-7.39
Chandi	28.00	24.00	-14.29	93.25	90.00	-3.49
Sindh-1	27.00	25.00	-7.41	93.50	91.25	-2.41
NIAB-78	26.75	23.00	-14.02	96.00	90.75	-5.47
CIM-496	28.50	26.00	-8.77	100.50	95.75	-4.73
CIM-499	27.00	25.50	-5.56	103.00	94.00	-8.74
CIM-506	27.50	25.00	-9.09	107.00	102.00	-4.67
CIM-534	28.25	26.00	-7.96	102.50	97.00	-5.37
BH-160	29.75	24.00	-19.33	96.50	90.50	-6.22
Bt-cotton	27.00	23.00	-14.81	95.00	90.00	-5.26
Mean	27.52	24.75	-10.07	99.19	94.08	-5.15
LSD(5%) Genotypes (G)	0.70			0.89		
Treatment (T)	0.28			0.36		
G x T	0.99			1.25		

*RD = Relative decrease due to water stress.

Table 7.Mean performance for seed cotton yield (kg ha^{-1}) of cotton genotypes grown under non-stress and water stress conditions

Genotypes	Seed cotton yield (kg ha^{-1})		RD*(%)
	Non-stress	Water stress	
CRIS-134	4070.00	3200.00	-21.38
CRIS-342	3600.00	2800.00	-22.22
Sadori	4082.50	3150.00	-22.84
Chandi	3537.50	2600.00	-26.50
Sindh-1	3900.00	3075.00	-21.15
NIAB-78	3877.50	2600.00	-32.95
CIM-496	3925.00	3200.00	-18.47
CIM-499	3155.00	2365.00	-25.04
CIM-506	3800.00	2825.00	-25.66
CIM-534	3700.00	2687.50	-27.36
BH-160	3547.50	2250.00	-36.58
Bt-cotton	3950.00	2350.00	-40.51
Mean	3762.08	2758.54	-26.68
LSD(5%) Genotypes (G)	67.04		
Treatment (T)	27.37		
G x T	94.81		

*RD = Relative decrease due to water stress.

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