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Research Article

Asessment of elite Indian wheat genotypes for drought tolerance

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Abstract
To understand the plasticity of adaptation to different environmental conditions, eighteen elite wheat genotypes were evaluated for two seasons (2017-18 and 2018-19) under water-stress and controlled environments at ICAR-Indian Agricultural Research Institute (IARI), Regional station, Indore, India. Combined analysis of variance for grain yield under both water regimes showed that effects due to the water regimes, environment and genotype all interactions were found to be significant. Genotypes viz., NI 5439, HI 8791and HI 1531 were found to perform stable under both water regimes with high mean yield. Based on PCA biplot and GGE biplot analysis it is evident that genotypes HI 8793, HI 8790 and HI 1619 were the highly adapted, most stable and high yielding genotypes. HI 8791, HI 1531, NI 5439, HI 8793, HI 8790 and HI 1619 were identified to be stable for grain yield and can be utilized further in the breeding program for climate resilient wheat varieties development.

Keywords: Wheat, Drought, GGE biplot, PCA, yield

INTRODUCTION

Wheat (*Triticum spp.*) is the most important cereal crop that contributes to one-third of the total food grain production in India with a production of 113 million tonnes from 31.4 million hectares during 2023-24 (ICAR-IIWBR, 2024). Abrupt climate change, diminishing natural resources and reduced inputs threaten to reduce potential productivity of wheat (Ruchita and Rohit, 2017). By 2050, it is predicted that irrigated wheat and maize yields may decline by 5-10% and rain-fed agriculture, which covers 60 per cent of all the cultivated land in India, will be particularly hard hit (Singh *et al.,* 2020). Among abiotic stresses posed by the climate change, heat and drought stress tops the slot affecting the wheat growth and development in central India where both durum wheat and bread wheat are grown. The most practicable solution for these problems is to develop wheat cultivars with improved genetic yield potential (Sareen *et al.,* 2023) and wider adaptability and resistance to drought and heat (Maria *et al*., 2020). Drought tolerance is a complicated trait, which is controlled by polygenes and their expression is influenced by different environmental elements and genotype x environment interaction (Bapela *et al*., 2022). Better understanding of the genetic basis of morphological and physiological traits and their variability under water stress will improve the efficiency of wheat selection for drought tolerance. Various stress indices *viz.,* Mean productivity (MP), stress tolerance Index (STI), stress susceptibility index (SSI) and tolerance index (TI) were used to predict the best performers under stress and non-stress conditions and selection based on a combination of indices was done (Lamba *et al.,* 2023). To analyse GE interaction further graphically, GGE biplot has been proposed (Gupta *et al.,* 2022 & Saeidnia *et al.,* 2023). It is a useful tool for plant breeders and geneticists to find out the maximum yielding and stable genotypes across multiple locations as well as to find out the best favorable location for a specific genotype through acquiring a graphical form. Selection of genotypes based on drought adaptive traits along with the yield and its components may improve yield under target environment (Varshney *et al.,* 2021). By keeping the above into consideration, the present investigation was intended to understand the plasticity of genotype adaptation to moisture stress conditions using morpho-physiological traits as well as to identify wheat genotypes with stable and high yield across years.

MATERIALS AND METHODS

Experimental material and design: The experimental material include 18 wheat genotypes of both bread and durum wheat released for restricted irrigation conditions of central and peninsular zones as well as advanced wheat lines tested under All India co-ordinated trials of wheat selected based on their performance of the previous year (2016-17) (**Table 1**). These genotypes were evaluated in the fields of ICAR-IARI, Regional station, Indore situated at lat. 22.8°N, long. 75.4°E, alt 555 MSL. At Indore, temperature was recorded in the range of 23°C to 41°C and 7°C to 29°C during summer and winter seasons respectively with semi-arid and humid climate. Most of the rainfall was received during south-west monsoon, *i.e.,* between June to September, with occasional showers in winter. The weather parameters recorded during the experiment period are presented in the **table 2**.

The entries were evaluated under two water regimes, *i.e.,* restricted irrigation (RI) and optimum irrigation (OI) for two crop seasons *i.e.,* 2017-18 and 2018-19, totally making four experiments. The test genotypes were sown in a randomized block design with two replications, and each test plot is represented by two rows of 2.5 m long and 20 cm apart under restricted irrigation and optimum irrigation conditions. The wheat genotypes were randomly assigned to plots within each block, with one block under drought stress, and the other block where irrigation was provided and the genotypes were randomized. Crop was raised as per the package of practices under both conditions to get the best expression. The data of six yield and yield contributing components were recorded *viz.,* days to heading (DTH), plant height (PH), number of tillers per meter (NOT/m), spikelets/spike (s/spike), thousand grain weight (TGW) and grain yield (GY).

Statistical Analysis and estimation of drought tolerance indices: Drought tolerance indices viz., Mean productivity (MP), Tolerance index (TI), Yield stability index (YSI), Stress tolerance index (STI) and Stress Susceptibility index (SSI)for each genotype were calculated (Rosielle and Hamblin 1981, Bouslama and Schapaugh 1984, Fernandez 1992). The data of yield and yield attributing traits collected were subjected to ANOVA and Principal component analysis (PCA) to detect underlying sources of morphological variability, and to investigate patterns of genetic diversity using PAST 3 software. To determine the effects of GEI on grain yield, the yield data recorded from all the environments were subjected to GGE biplot analysis using Gen Stat 14th edition (VSN International, Ltd, Hemel Hempstead, UK). The genetic correlation coefficient was calculated using OPSTAT software.

RESULTS AND DISCUSSION

Combined variance analysis for yield and its related traits

The main effect [genotypes G (σ_g^2) and water regimes WR

Table 1. Details of the experimental material used in the study

Genotype	Pedigree	Origin
AKAW 3717	HW 2035/NI 5439	PDKV, Akola
C306	REGENT1974/3*CHZ//*2C591/3/P19/C281	CCS HAU, Hissar
DBW 110	KIRITATI/4/2*SERI1B*2/3/KAUZ*2/BOW//KAUZ	IIWBR, Karnal
HD 4672 (d)	BIJAGA RED /PBW34 //ALTAR 84	ICAR-IARI, RS, Indore
HI 1500	HW 2002*2//STREMPALLI/PNC 5	ICAR-IARI, RS, Indore
HI 1531	HI 1182/CPAN 1990	ICAR-IARI, RS, Indore
HI 1605	BOW/VEE/5/ND/VG9144//KAL//BB/3/YACO/4/CHIL/6/CASKOR/3/CROC_1/A.SQUARROSA(224)//OPATA/7/PASTOR//MILAN/KAUZ/3/BAV92	ICAR-IARI, RS, Indore
HI 1619	W15.92/4/PASTOR//HXL7573/2*BAU/3/WBLL1	ICAR-IARI, RS, Indore
HI 8627 (d)	HD 4672 / PDW 233	ICAR-IARI, RS, Indore
HI 8731 (d)	Jairaj/HD 4672//HD 4672	ICAR-IARI, RS, Indore
HI 8776 (d)	HI 8663 / HI 8627	ICAR-IARI, RS, Indore
HI 8789 (d)	HI 8663 / HI 8627	ICAR-IARI, RS, Indore
HI 8790(d)	HI 8627 / HI 8653	ICAR-IARI, RS, Indore
HI 8791 (d)	HI 8663 / HI 8627	ICAR-IARI, RS, Indore
HI 8792 (d)	Jairaj / HD 4672 // HD 4672	ICAR-IARI, RS, Indore
HI 8793 (d)	HI 8504 / CPAN 6206// HI 8627	ICAR-IARI, RS, Indore
MP 3288	DOVE/BUC/DL788-2	JNKVV, Jabalpur
NI 5439	NI8883/MP1055	MPKV, RS, Niphad

Table 2. Meteorological data during the crop season 2017-18 and 2018-19

Month	Temperature (°C) Mean		Rainfall (mm)	No. of rainy days	Relative Humidity (mm)
	Min.	Max.			
Sep 2017	24.5	30.1	5.0	0.3	80.4
Sep 2018	21.2	30.7	51.0	2	76.4
Oct 2017	24.8	31.3	0.0	0	69.4
Oct 2018	18.2	34.7	0.0	0	71.1
Nov 2017	29.8	12.2	0.0	0	71.5
Nov 2018	14.0	33.7	0.0	0	72.5
Dec 2017	9.8	26.7	0.0	0	74.3
Dec 2018	9.2	28.4	0.0	0	75.8
Jan 2018	9.0	27.6	0.0	0	77.3
Jan 2019	9.2	26.4	0.0	0	75.2
Feb 2018	11.5	31.7	0.0	0	77.2
Feb 2019	11.7	29.1	0.0	0	73.6
March2018	17.7	36.8	0.0	0	64.1
March2019	16.4	36.3	0.0	0	68.6
April 2018	22.0	40.2	0.0	0	59.5
April 2019	21.3	41.7	0.0	0	63.9

((σ^2wr)) and the interactions among and within the source of variations combined analysis of variance for six major yield contributing traits were found significant at P<0.01 for studied traits except for s/spikes and TGW (**Table 3**). Variance due to year Y (σ^2y)was significant for all the six yield attributing traits indicating that the evaluation years in this were different. Variance due to genotype by water regime interaction (GxWr) and interaction among three components (GxWrxY) was found to be significant for NOT/m and grain yield, whereas variation due to genotype and year was significant for all traits except s/spike. The water regimes effect was the most important source of yield variation, accounting for 49.1% of the total sum of squares (TSS) followed by environment with 42.1%. These two components accounted for more than 91% of total variation in the experimental material.

Mean performance and ranking of genotypes based on agronomic traits : The mean yield and its attributing traits pooled across two environments are presented in **table 4.** The mean grain yield of the test genotypes under restricted irrigation conditions (597 g/plot) was reduced by 32.4% compared to irrigated conditions (791g/plot). The highest yield under drought condition recorded by genotype HI 1531 (693 g/plot) followed by genotypes HI 8793(d) (689 g/plot), AKAW 3717 (646 g/plot) whereas the highest grain yield in irrigated condition is recorded by HI 8793 (d) (1010 g/plot) followed by HI 8792 (d) (860 g/plot), HI 1619 (838 g/plot). In case of restricted irrigation condition GY was significantly and positively correlated with only NOT/m, whereas all other traits showed non-significant association with grain yield. In case of optimum irrigation condition significant and positive correlation of grain yield was recorded with TGW and all other traits showed non-significant association with grain yield in optimum irrigation condition (**Table 5**). The results were supported by the previous studies by Ahmad *et al.* (2022) Semahegn *et al.* (2020) and Kumar *et al*. (2020). Days to heading of the test genotypes were found to be early by two days and plant height and number tillers per meter were found to be low under restricted irrigation conditions compared to optimum irrigated conditions. However, mean thousand grain weight reduced under optimum irrigated conditions in comparison with drought stress in case of bread wheat entries where as *vice versa* in case of durum wheat genotypes. The mean yield data indicated that HI 1531, HI 8793(d) and AKAW 3717 were best performers under drought stress conditions whereas; HI 8793(d), HI 8792(d) and HI 1619 did well in irrigated conditions. HI 8793 (d) was the common genotype which performed well across both water regimes which may be because of high tiller number and thousand grain weight.

Mean performance and ranking of genotypes based on drought indices: The performance of the test genotypes as assessed through drought indices (**Table 6**) showed that mean productivity (MP) which indicates the mean yield of a genotype under two environments was high in HI 8793(d) as the genotype performed well under both the conditions followed by HI 8792(d) and HI 1531. Tolerance Index (TI) was observed to be low for HI 8791(d) followed by NI 5439 and HI 1531 which shows these entries have lower yield difference among drought and irrigated conditions. HI 8793(d), HI 8731(d) and HI 8790(d) were seen to have high tolerance index indicating their suitability for irrigated conditions compared to limited

Table 3. Combined analysis of variances for ten phenotypic traits of 18 wheat genotypes across two water regimes and two seasons

SOV	DF	DTH	PH	NOT/m	s/spike	TGW	GY	%TSS
Genotype (G)	17	35.08**	623.6**	806.4**	1.77ns	100.75**	25447**	0.9
Water regimes (WR)	1	177.7**	2652.25**	39578.8**	30.34**	31.91 ns	1366756**	**49.1**
Year (Y)	1	3721**	2256.25**	32861.6**	66.28**	368.38**	1172348**	**42.1**
G x WR	17	2.6 ns	58.08 ns	312.6**	2.03ns	14.16 ns	10517**	0.4
G x Y	17	53.2**	518.4**	704.52**	1.99 ns	62.6**	64935**	2.3
WR x Y	1	100**	300.4**	79.01	29.5**	46.12	15543**	4.2
G x WR x Y	17	3.29 ns	22.72 ns	375.34**	1.76 ns	15.51 ns	23017**	0.8
Residual	71	3.31	41.48	76.03	1.73	13.55	3600	0.1
T test (P value)	-	o.oo2	0.003	0.00001	0.0008	0.23	0.00001	-

**Significant at 1% level of probability, we can add * upto 5% as it is field experiment and ns= non-significant
DTH: Days to heading; PH: plant height; NOT/m: Number of tillers/m; S/Spike: Spikelets/spike; TGW: Thousand grain weight; GY: Grain yield

Table 4. Mean values of six traits under two water regimes (Drought & irrigated)

Genotype	DTH		PH(cm)		NOT/m		TGW(g)		GY(g/plot)	
	D	I	D	I	D	I	D	I	D	I
AKAW 3717	74	76	93	111	118	125	47.6	42.1	646	785
C306	78	82	101	117	103	144	43.3	39.8	557	697
DBW 110	79	80	76	89	86	108	47.6	43.4	574	762
HD 4672 (d)	73	75	83	90	93	120	47.1	45.3	592	806
HI 1500	74	77	94	95	88	124	49.8	49.0	583	760
HI 1531	77	79	101	111	96	114	45.3	42.8	693	800
HI 1605	77	81	88	97	76	123	47.5	46.6	516	694
HI 1619	80	82	82	93	88	131	52.2	51.9	643	838
HI 8627(d)	76	77	83	90	70	113	50.6	49.6	542	832
HI 8731(d)	75	76	78	91	68	112	51.2	52.3	483	783
HI 8776(d)	76	79	77	84	94	101	49.6	50.0	629	772
HI 8789(d)	75	79	79	84	86	126	50.0	50.3	592	812
HI 8790(d)	75	78	94	100	75	105	53.3	54.4	540	833
HI 8791(d)	75	77	95	91	95	131	46.9	45.9	594	675
HI 8792(d)	73	75	92	102	89	125	51.8	51.3	642	860
HI 8793(d)	77	79	85	90	84	133	47.4	51.6	689	1010
MP 3288	78	81	82	91	92	125	45.2	48.8	578	795
NI 5439	75	74	98	112	100	137	44.5	39.0	644	731
Mean	76	78	88	96	88	122	48.3	47.4	597	791
SED	5.32	4.35	8.7	7.8	16.0	16.6	2.8	4.14	85.7	146
LSD(5%)	10.6	8.73	17.5	15.6	32.1	33.4	5.7	8.31	171.8	292.9
T value		-2.98		-2.83		-8.43		-0.73		-8.72
P value		0.002		0.0038		0.00001		0.232ns		0.00001

DTH: Days to heading; PH: plant height; NOT/m: Number of tillers/m; S/Spike: Spikelets/spike; TGW: Thousand grain weight; GY: Grain yield; D: Drought; I: Irrigated

irrigation conditions. Yield stability index (YSI) indicated that NI 5439 was showing higher stable performance under both water regimes followed by HI 8791(d) and HI 1531 indicating these entries performed stable under both water regimes. Stress tolerance index was high for HI 8793(d) followed by HI 1531 and HI 8792(d). Stress

Table 5.Correlation coefficients among yield and other traits

	DTH	PH (cm)	NOT/m	s/spike	TGW(g)	GY(g/plot)
DTH	1	-0.211^{NS}	-0.090^{NS}	0.035^{NS}	-0.211^{NS}	0.023^{NS}
PH	-0.101^{NS}	1	0.452^{NS}	0.513*	-0.399^{NS}	0.264^{NS}
NOT/m	0.090^{NS}	0.430^{NS}	1	0.646**	-0.576*	0.591**
s/spike	0.252^{NS}	-0.220^{NS}	0.076^{NS}	1	-0.412^{NS}	0.329^{NS}
TGW	0.069^{NS}	-0.636**	-0.398^{NS}	0.254^{NS}	1	-0.226^{NS}
GY	-0.055^{NS}	-0.262^{NS}	-0.093^{NS}	0.212^{NS}	0.559*	1

* Restricted Irrigation above diagonal & Optimum irrigation below diagonal
DTH: Days to heading; PH: plant height; NOT/m: Number of tillers/m; S/Spike: Spikelets/spike; TGW: Thousand grain weight; GY: Grain yield

Table 6. Drought tolerance Indices of 18 wheat genotypes

Genotype	Y_D	Y_I	MP	TI	YSI	STI	SSI
AKAW 3717	646 (3)	785(10)	716(5)	139(4)	0.82(4)	0.81(5)	0.72(4)
C306	557 (14)	697(16)	627(17)	140(5)	0.80(6)	0.62(16)	0.82(6)
DBW 110	574(13)	762(13)	668(14)	188(9)	0.75(9)	0.70(14)	1.00(9)
HD 4672 (d)	592(9)	806(7)	699(8)	214(11)	0.73(12)	0.76(8)	1.08(12)
HI 1500	583(11)	760(14)	672(13)	177(7)	0.77(8)	0.71(13)	0.95(8)
HI 1531	693(1)	800(8)	747(3)	107(3)	0.87(3)	0.89(2)	0.54(3)
HI 1605	516(17)	694(17)	605(18)	178(10)	0.74(11)	0.57(18)	1.04(11)
HI 1619	643(5)	838(3)	741(4)	195(8)	0.77(7)	0.86(4)	0.94(7)
HI 8627(d)	542(15)	832(5)	687(10)	290(15)	0.65(16)	0.72(11)	1.42(16)
HI 8731(d)	483(18)	783(11)	633(16)	300(17)	0.62(18)	0.60(17)	1.56(18)
HI 8776(d)	629(7)	772(12)	701(7)	143(6)	0.81(5)	0.78(6)	0.75(5)
HI 8789(d)	592(10)	812(6)	702(6)	220(14)	0.73(13)	0.77(7)	1.10(13)
HI 8790(d)	540(16)	833(4)	687(11)	293(16)	0.65(17)	0.72(12)	1.43(17)
HI 8791(d)	594(8)	675(18)	635(15)	81(1)	0.88(2)	0.64(15)	0.49(2)
HI 8792(d)	642(6)	860(2)	751(2)	218(13)	0.75(10)	0.88(3)	1.03(10)
HI 8793(d)	689(2)	1010(1)	850(1)	321(16)	0.68(15)	1.11(1)	1.29(15)
MP 3288	578(12)	795(9)	687(12)	217(12)	0.73(14)	0.73(10)	1.11(14)
NI 5439	644(4)	731(15)	688(9)	87(2)	0.88(1)	0.75(9)	0.48(1)

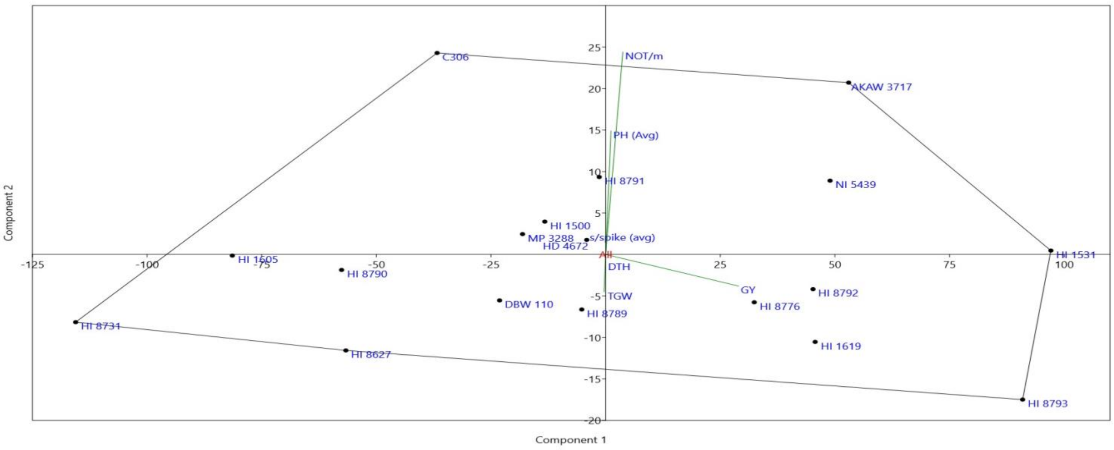
The numbers in the parentheses are the ranks of the genotype for each index. Y_D –grain yield (in grams) under stressed environment, Y_I–Grain yield (in grams) under non-stressed environment, MP –mean productivity, TI –tolerance index, YSI-Yield Stability Index, STI –stress tolerance index, SSI –stress susceptibility index

susceptibility index (SSI) appeared to be low for NI 5439 followed by HI 8791(d) and HI 1531 which shows that these genotypes have low drought susceptibility and high yield stability without much effect on the yield under both the environments. The yield traits and drought tolerance indices viz., MP, TI, YSI and SSI studied in the experiment indicated that NI 5439 followed by HI 8791(d) and HI 1531 were found to perform stable under both water stress and irrigated conditions. HI 8731(d) and HI 8627(d) were found to be have less yield stability across two water regimes. However, the durum wheat entries considered in the study except HI 8791(d) and HI 8776(d) were found to perform better under irrigated conditions and bread wheats were found to be yielding superior under drought stress conditions. Over all, HI 8793(d) and HI 1619 were found to be high yielding and stable genotypes across environments with high mean productivity, TI, STI and low SSI. Similar results were observed by Anwaar *et al*. (2020), Ayed *et al.* (2021) and Jayshree Priyanka *et al.* (2024). The genotypes having high SSI *viz.,* HI 8731(d) and HI 8627(d) on the other hand were found to have poor yield stability under two water regimes indicating that these are the more suitable for irrigated conditions. The results of ranking based on agronomic traits and drought indices indicated that genotypes *viz*., HI 8793 (d), HI 8791(d), NI 5439 and HI 1619 which

Table 7. Rotated component matrix of phenotypic traits of 18 wheat genotypes evaluated in two years under restricted and optimum irrigation conditions

Traits	Restricted Irrigation			Optimum irrigation		
	PC 1	PC 2	PC 3	PC 1	PC 2	PC 3
DTH	0.001	-0.034	-0.042	-0.002	0.000	0.067
PH	0.040	0.509	0.856	-0.036	0.571	-0.788
NOT	0.128	0.834	-0.514	-0.015	0.800	0.595
S/ Spike	0.005	0.047	0.004	0.002	-0.001	0.020
TGW	-0.012	-0.155	0.026	0.034	-0.177	0.142
GY	0.991	-0.130	0.032	0.999	0.038	-0.024
Explained Variance (Eigen values)	3354.360	115.132	46.426	5703.12	166.36	63.46
Proportion of total variance (%)	95.161	3.266	1.317	95.90	2.80	1.07
Cumulative variance (%)	**95.160**	**98.420**	**99.730**	**95.9**	**98.7**	**99.77**

a) Restricted Irrigation



b) Optimum irrigation

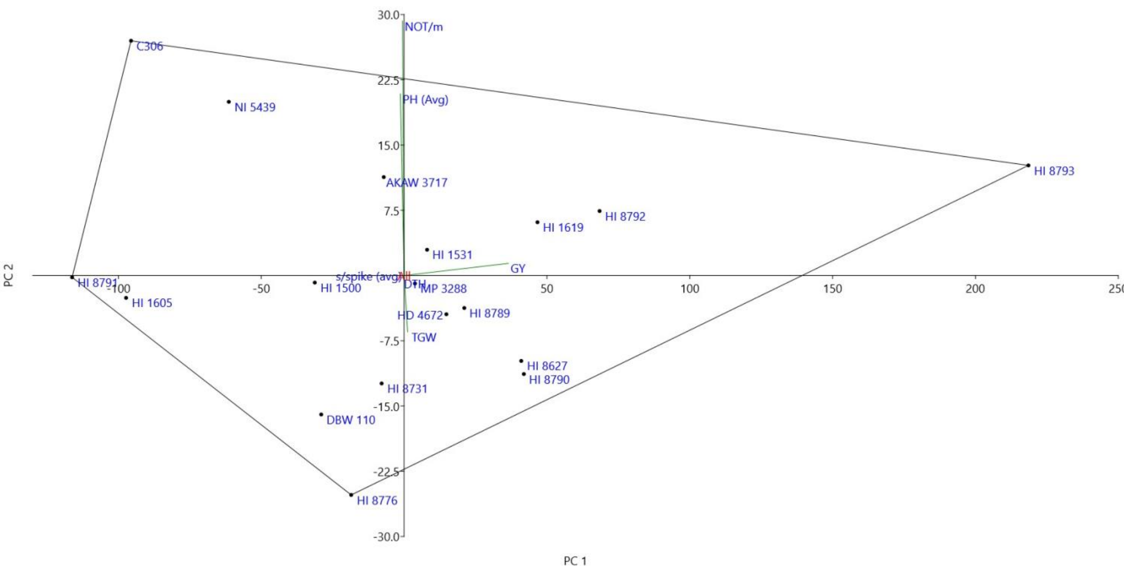


Fig. 1. **PCA biplots for grain yield and yield contributing traits in restricted irrigation and optimum irrigation condition**

were bred for drought tolerance were found to be best genotypes due to the superiority in yield attributing traits viz., thousand grain weight in HI 1619 and HI 8793. NI 5439 was found to have high number of tillers/m which led to its best performance under both drought and irrigated conditions.

Principal component analysis (PCA): PCA of the morpho-physiological traits revealed that first three principal components (PCs) explained more than 99 percent of variation (**Table 7**). PCA biplot showed that grain yield, NOT/m and plant height contributed to the maximum variance for PC1 in drought condition, whereas grain yield and TGW were the top contributors for PC1 under optimum irrigation condition. As the first two PCs explained significant portion of variance in the data, the data is visualized by projecting the observations on to the span of two PCs as PCA biplot in two-dimensional view (Chaouachi *et al.,* 2023)(**Fig. 1a & 1b**). It also depicted that grain yield has a strong positive correlation with NOT/m and plant height. However, thousand grain weight was positively correlated to yield under optimum irrigation conditions and negatively correlated under RI conditions. PCA biplot showed that HI 8793 (d) was the high yielding genotype under both water regimes and showed stable performance under optimum irrigation conditions. AKAW 3717, NI 5439 and HI 1531 were the best yielders under restricted irrigation conditions and showed stable performance under both irrigation conditions. C 306 was found to show stable performance under RI conditions even though a low yielder. HI 8790 and HI 8627, two durum wheat genotypes were best performers under HF conditions with less stability across environments. Inference from the PCA biplot can be drawn as phenotyping based on the physiological traits under water stress conditions can help to select the drought resistant genotypes in wheat.

GGE Biplot pattern for elucidation of multivariate analysis
The GGE biplot analysis showed that existence of GE crossover and grain yield and testing environments were partitioned into clusters. One cluster comprised of two water regimes of 2017-18 with HI 8793(d) and HI 8776(d) as the winning genotypes, second cluster encompassed optimum irrigation of 2018-19 with HI 1500 as the winning genotype, while third cluster was represented by RI 2018-19 with C 306 as the winning genotype. There were also genotypes in regions with no environment at all, which means that such genotypes had a poor performance in all environments *viz.,* HI 1605. The genotype ranking for grain yield is shown on the graph of so-called "ideal" genotype (**Fig. 2**). An 'ideal genotype' is high performer with high stability across environments (Yan and Tinker 2006). Such an ideal genotype is defined by having the greatest vector length of the high yielding genotypes and with zero GEI, as represented by an arrow pointing to it (**Fig.3**).

A genotype is more desirable if it is located closer to the ideal genotype. Thus, using the ideal genotype as the centre, concentric circles were drawn to help visualize the distance between each genotype and the ideal genotype. Both the biplot analysis showed that HI 1605, NI 5439 and C 306 were found to be away from ideal genotype indicating their poor performance and yield stability. Ranking of genotypes for both mean yield and stability performance across the three clusters, HI 8793(d) followed by HI 1619 and HI 8790(d) were ranked closest

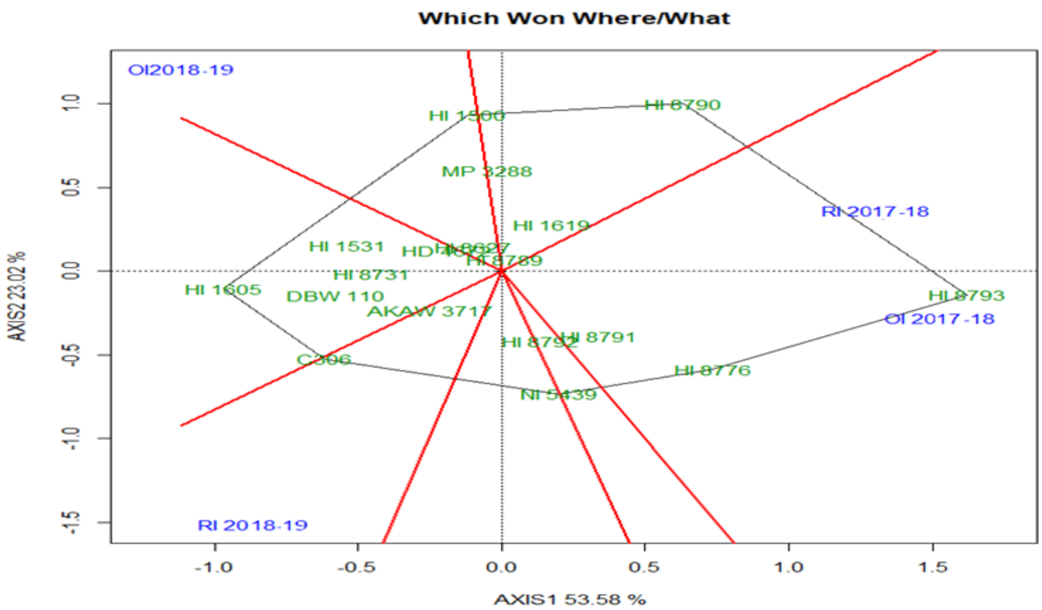


Fig. 2. **Polygon view of GGE biplot showing "which won where" pattern for genotypes and environments**

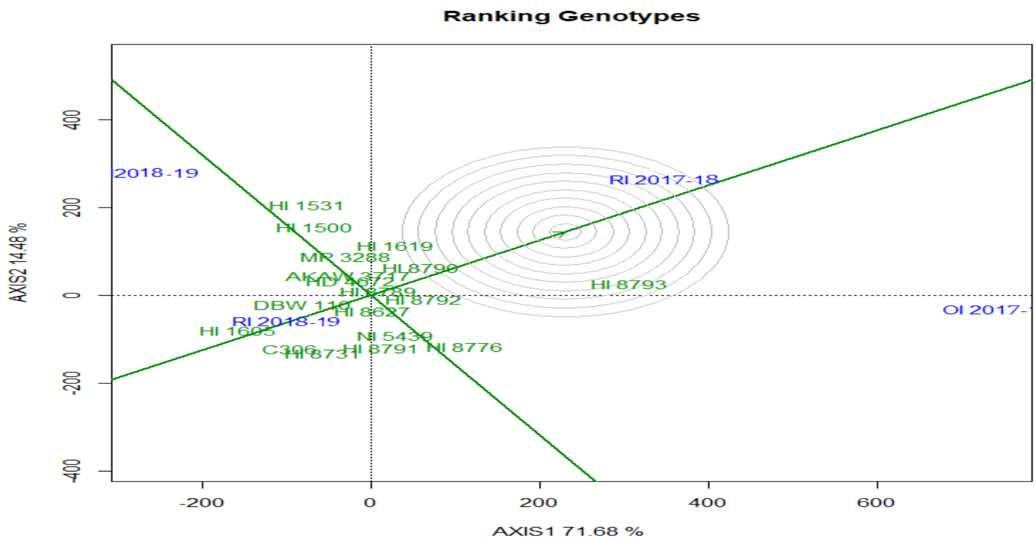


Fig. 3. **GGE biplot based on genotype-focused scaling for comparison of the genotype with ideal genotype**

to ideal genotype, indicating them as the most desirable genotypes out of 18 genotypes studied. The results of GGE biplot showing the genotypes HI 8793(d) followed by HI 1619 and HI 8790(d) were as the most stable genotypes out of 18 genotypes studied. Stability of these genotypes was the reflection of high yield, thousand grain weight and number of tillers/m under both environments. Hence these genotypes could be recommended for wide cultivation in different water regime conditions of wheat growing areas in India mainly in central and peninsular India where drought stress is a major concern.

The 18 wheat genotypes considered for study showed the presence of considerable variation for the yield and it attributing traits studied and the effects due to the environment (year), water regimes, genotype and interaction of these components were found to be significant for grain yield. HI 8793(d) and HI 1619 were found to be high yielding and stable genotypes across environments with high mean productivity, TI, STI and low SSI. GGE biplots showed that HI 8790 (d), HI 8793 (d) and HI 1619 were high yielders with good stability across the test environments. Six wheat genotypes *viz.,* HI 8791(d), HI 1531, NI 5439, HI 8793(d), HI 8790 (d) and HI 1619 were identified to be stable for grain yield under both water regimes and can be utilized further in the breeding program for climate resilient wheat varieties development. As durum wheat and bread wheat were reported to have different abilities to adapt to various abiotic stresses, these genotypes could be potential donors for interspecific crosses leading to development of climate resilient wheat genotypes with wider adaptability. Their pedigree indicates these genotypes with different genetic back grounds and stable performance across seasons can enrich the drought resistant germplasm and can be further utilized to enhance the breeding programs.

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