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RESEARCH PAPER

Multi-Season field evaluation: Identification of potential genetic stocks for salinity tolerance in wheat

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Abstract: Wheat (*Triticum* spp.) is a vital cereal crop worldwide. Salinity remains a major abiotic stress restricting wheat productivity, particularly in arid and semi-arid regions. Based on previous screening during *rabi* 2020–21, three genotypes UAS BW-13892, GPM DIC 101 and GPM DIC 107 were identified as promising for salinity tolerance using stress indices (SSI and STI), screening for seedling traits under hydroponic, growth and yield performance under natural saline conditions. These genotypes were subsequently evaluated in detail across three consecutive *rabi* seasons (2021-22, 2022-23 and 2023-24) at Ugar Khurd, Karnataka, under both saline and non-saline (control) environments to assess their performance. The experiments were conducted in a randomized complete block design with two replications. Soil electrical conductivity (ECe) in saline plots was maintained above 4 dS/m, while control plots remained below 2 dS/m. Pooled ANOVA was performed across years, genotypes and conditions. Significant ($P \leq 0.01$) variation was observed among genotypes and environments for all traits. The genotype × condition interaction was significant for most parameters, indicating differential responses to salinity. UAS BW-13892 exhibited early maturity, high biomass (106-121 q/ha) and stable thousand-grain weight (41-42 g) under salinity. GPM DIC 101 showed superior tillering ability (163-169 tillers/m) and shorter stature, while GPM DIC 107 maintained high chlorophyll content and biomass under non-stress conditions. The results indicate stable performance and adaptability across saline environments. Their tolerance mechanisms early maturity, efficient biomass production, high tillering ability and maintenance of grain weight highlight their potential as valuable genetic resources for wheat improvement under salt-affected soils.

Key words: Bread wheat, Dicoccum wheat, Salinity, Stress, Wheat

Introduction

Wheat is one of the world's most important cereal crops, cultivated across diverse environments and covering more than 217 million hectares globally the largest acreage of any crop. It produces about 731 million tonnes annually (USDA, 2022) and serves as a staple food for nearly 2.5 billion people.

India ranks second after China in wheat production, benefitting from its diverse agro-ecological conditions. In recent years, wheat has played a central role in ensuring national food and nutritional security through consistent production and supply (Sharma and Sharma, 2025; Banik and Mukhopadhyay, 2022). Karnataka is unique among Indian states, as all three cultivated wheat types *Triticum aestivum*, *T. durum* and *T. dicoccum* are grown under tropical conditions, often exposed to high temperatures throughout the crop cycle (Biradar *et al*., 2022).

Genetic improvement is therefore recognized as the most sustainable strategy to enhance wheat productivity (Akbari *et al*., 2022). Among various yield-limiting factors, abiotic stresses particularly salinity play a major role in reducing wheat yield and quality (Osama, 2025; Jha *et al*., 2022; Khavarinejad and Karimov, 2012). In India, around 6.73 million hectares are salt-affected, comprising 3.77 million hectares of sodic soils and 2.96 million hectares of saline soils (Kumar *et al*., 2022). Gujarat leads with 2.23 million hectares of saline soils, followed by Uttar Pradesh (1.37 million hectares), while Karnataka accounts for 0.24 million hectares (Sharma and Singh, 2015). Within Karnataka, salinity is particularly severe in the districts of Bagalkot, Belagavi, Chitradurga and Davanagere (Raitamitra, 2016).

Salinity impairs seedling growth, reduces chlorophyll content and disrupts ionic balance. Tolerance levels vary among wheat species, with bread wheat generally more tolerant than dicoccum and durum (El Sabagh *et al*., 2021; Seleiman *et al*., 2022). Salt stress reduces plant productivity primarily by limiting water uptake, disrupting photosynthesis and inducing ionic toxicity (Ondrasek *et al*., 2022). Physiological traits linked to salt tolerance include restricted Naz transport to shoots and enhanced Kz /Naz selectivity (Joshi *et al*., 2022). Such traits can serve as selection criteria in breeding programs. Variation in morpho-physiological and agronomic traits among genotypes plays a crucial role in yield stability and has been exploited in breeding programs to develop varieties adapted to saline conditions (Chaurasia and Singh, 2022). However, progress has been limited due to the complex genetic nature of the trait, incomplete understanding of its physiological and molecular mechanisms, lack of reliable selection criteria and poor correlation of tolerance across developmental stages.

Material and methods

Initially 140 genotypes were evaluated under both saline and control conditions (Malipatil *et al*., 2022; Malipatil *et al*., 2023a; Malipatil *et al*., 2023b; Malipatil *et al*., 2023c). These genotypes were also tested under hydroponic conditions with four NaCl treatments (0, 75 mM, 150 mM and 225 mM) to assess salinity tolerance at the seedling stage (Malipatil *et al*., 2025). Based on stress indices (SSI and STI) and combined results from field and hydroponic screenings, one bread wheat line (UAS BW 13892) and two dicoccum lines (GPM DIC 101 and GPM DIC 107) were identified as tolerant and high-yielding under saline conditions. The present investigation focused on evaluating these three salt-tolerant lines along with suitable checks during *rabi* 2021-22, *rabi* 2022-23 and *rabi* 2023-24 at Ugar Sugars Pvt. Ltd., Ugar Khurd, Tq. Chikkodi, Dt. Belagavi, Karnataka to assess their stability. The experimental site is located in the northern transitional tract of Karnataka at 16°382 N latitude, 74°492 E longitude and an altitude of 537 m above mean sea level (AMSL). The checks included: released salt-tolerant wheat cultivars from the Central Soil Salinity Research Institute (CSSRI), Karnal; Kharchia 65, the only widely recognized donor of salt tolerance in wheat; a registered national genetic stock from the National Bureau of Plant Genetic Resources (NBPGR), New Delhi; and released cultivars from UAS, Dharwad.

Two independent experiments were conducted under both saline and control conditions in a randomized complete block design (RCBD) with two replications. Each genotype was grown in two rows of 3 m length with 20 cm spacing between rows. Saline plots were maintained at pH< 8.0 and EC > 4 dS/m, while control plots were maintained at pH 6-8 and EC <2dS/m across all four seasons. Soil samples were collected at different crop stages sowing, booting, grain filling and harvest from the topsoil (0-20 cm) and subsoil (20-40 cm) layers to monitor salinity by measuring pH and EC (1 soil: 2.5 water). Seasonal values of soil pH and EC are presented in Table 1.

Observations were recorded at different crop growth stages on morphological, physiological and yield-related traits. Morphological and yield parameters included days to 50% flowering (DF), days to maturity (DM), plant height (PH), number of productive tillers per meter row (TPM), thousand-grain weight (TGW), biomass weight (BM) and grain yield (GY, q/ha). Physiological traits such as SPAD values were recorded at the grain-filling stage. To evaluate the effects of genotype and genotype × environment interactions, analysis of variance (ANOVA) was performed separately for saline and control conditions across years. Additionally, pooled ANOVA was performed out to assess the effects of salinity, growing seasons, genotype and their interactions on the measured traits.

Table 1. Soil pH and electrical conductivity in saline and control plots at various crop growth stages over four seasons at Ugar Khud

		Saline plot							
Crop stage	Soil layer	pH				EC			
		2020-21	2021-22	2022-23	2023-24	2020-21	2021-22	2022-23	2023-24
Sowing	Top layer (0-20 cm)	8.01	7.65	7.71	7.89	6.56	6.08	6.42	5.72
	Bottom layer (20-40 cm)	7.98	7.51	7.69	7.84	6.51	6.04	5.95	5.63
Booting	Top layer (0-20 cm)	7.80	7.81	7.72	7.88	6.11	6.01	6.60	6.78
	Bottom layer (20-40 cm)	7.89	7.72	7.82	7.71	5.89	5.98	5.91	5.68
Grain filling	Top layer (0-20 cm)	8.02	7.88	7.68	7.93	6.02	6.45	5.88	6.89
	Bottom layer (20-40 cm)	7.77	7.62	7.59	7.61	6.11	6.56	6.51	6.67
Harvesting	Top layer (0-20 cm)	7.81	7.57	8.10	7.86	6.31	6.67	6.69	6.56
	Bottom layer (20-40 cm)	7.62	7.22	7.68	7.38	6.29	5.85	6.78	5.98
		Control plot							
Crop stage	Soil layer	pH				EC			
		2020-21	2021-22	2022-23	2023-24	2020-21	2021-22	2022-23	2023-24
Sowing	Top layer (0-20 cm)	8.02	7.77	6.57	6.98	2.89	2.56	2.25	2.30
	Bottom layer (20-40 cm)	8.01	7.35	7.54	7.67	3.01	2.64	2.49	2.22
Booting	Top layer (0-20 cm)	7.70	7.72	7.52	7.65	2.21	2.99	2.67	1.90
	Bottom layer (20-40 cm)	7.86	7.70	6.49	7.01	2.31	2.76	2.48	2.45
Grain filling	Top layer (0-20 cm)	7.95	6.89	7.47	7.36	3.32	3.11	3.10	2.61
	Bottom layer (20-40 cm)	7.99	7.75	7.44	7.34	3.11	3.09	2.49	2.22
Harvesting	Top layer (0-20 cm)	8.03	7.62	7.41	7.12	3.10	2.95	2.85	2.04
	Bottom layer (20-40 cm)	7.56	7.59	6.39	7.09	2.98	3.02	2.75	2.62

Table 2a. Combined analysis for agronomic traits under control conditions in wheat

Source	Df	DM	PH	SPAD	TPM	TGW	BM	GY
G	12	165.33**	538.68**	152.92**	5496.3**	93.16**	3338.83**	683.3**
S	3	15.76**	0.14	7.55*	9.6	0.19	95.17	90.88**
REP	1	1.38	0.94	0.21	0.35	3.81	0.2	76.16
G × S	36	1.8	3.98	3.25	38.37	2.53	58.68	17.98
Residuals	51	1.62	2.53	2.18	26.99	2.13	44.75	21.47

Table 2b. Combined analysis for agronomic traits under saline stress conditions in wheat

Source	Df	DM	PH	SPAD	TPM	TGW	BM	GY
G	12	231.74**	1074.17**	133.81**	6265.87**	117.89**	1766.3**	240.24**
S	3	12.83**	0.52	2.83	51.24	4.62	636.26**	37.36
REP	1	0.04	1.08	7.93	5.09	1.27	137.79	246.46**
G × S	36	2.71	13.56	3.53	31.7	2.73	74.36	17.08
Residuals	51	1.92	14	3.44	26.16	2.51	47.76	19.35

Table 2c. Combined analysis for agronomictraits under control and saline stress conditions from *rabi* 2021 to 2024 in wheat

Source	Df	DM	PH	SPAD	TPM	TGW	BM	GY
REP	1	0.94	2.01	2.77	1.39	0.34	63.78	298.32*
G	12	389.99**	1092.99**	162.41**	7713.4**	186.88**	2729.13**	732.65**
C	1	88.92**	9580.04**	2112.74**	25454.81**	54.72**	25970.7**	5556.72**
S	3	27.09**	0.13	7.84*	28.13	2.26	568.18**	112.43**
G × C	12	7.08**	519.86**	124.33**	4048.76**	24.16**	2376.01**	190.89**
G × S	36	2.1	7.34	4.2	29.19	2.34	67.27	14.47
C × S	3	1.5	0.53	2.54	32.71	2.55	163.25*	15.81

Results and discussion

Salinity is a major constraint to global agricultural productivity and poses a serious threat to food security. Among cereals, wheat is considered moderately salt-tolerant (Yadav *et al*., 2011). Plant breeding seeks to exploit the genetic variability and diversity present within *Triticum* species to improve salt tolerance mechanisms, yield and yield-related traits.

The results of the combined ANOVA for traits evaluated under both control (Table 2a) and salinity (Table 2b) stress conditions are presented in Table 1a and 1b. Significant differences were noted among genotypes for all studied traits under both conditions. Under saline conditions, days to maturity (DM) and biomass (BM) showed significant ($P \leq 0.01$) seasonal variation, while under control conditions, DM, SPAD and grain yield (GY) were significantly influenced by seasons. The genotype × season interaction was non-significant for all seven traits studied under both saline and control conditions.

Pooled ANOVA across years, genotypes and conditions (Table 2c) showed significant ($P \leq 0.01$) variation for all traits, except plant height (PH), tillers per meter (TPM) and thousand-grain weight (TGW) across seasons. The genotype × condition (G × C) interaction was significant ($P \leq 0.01$) for all traits. Similarly, genotype × season (G × S), condition × season (C × S) and genotype × condition × season (G × C × S) interactions were significant ($P \leq 0.01$) for most traits. However, for grain yield, C × S and G × C × S interactions were non-significant. These findings highlight the importance of the main effects of genotypes, conditions and seasons, along with their interactions and are in agreement with earlier reports (Kumar *et al*, 2017; ; Dubey *et al., 2022;* Al-Ashkar *et al*., 2019; Rohit and Suma 2020; Mubushar *et al*., 2022; Biradar *et al*, 2024).

Mean performance

The mean performance of the three genotypes along with the checks across all four years is presented in Tables 3 to 6. Among the three genotypes, UAS BW-13892 was found to be early maturing under both saline (90 to 92 days) and control (95 to 97 days) conditions. It also recorded the highest thousand-grain weight under both saline (41 to 42 g) and control (39 to 41 g) conditions. This bread wheat genotype produced the highest biomass under saline conditions (106 to 121 q/ha) and the highest SPAD values under control conditions (54 to 57), when compared with the other three genotypes. The dicoccum genotype GPM DIC 101 exhibited shorter plant height (87 to 91 cm) among the three genotypes, along with the highest

Table 3. Mean performance of wheat genotypes under saline and control condition of *rabi* 2020-21 at Ugar Khurd

Genotype	DM		PH		SPAD		TPM		TGW		BM		GY	
	C	S	C	S	C	S	C	S	C	S	C	S	C	S
UAS BW-13892	95	92	87.11	73.00	55.22	40.44	122	62	39.70	41.97	91.51	118.17	47.86	27.33
DIC-101	109	110	87.14	87.48	45.79	34.74	150	163	31.90	33.47	105.31	67.35	48.29	37.04
DIC-107	109	110	94.65	90.93	41.27	43.69	113	106	37.25	33.95	143.28	81.14	46.00	26.51
KRL 210 (BW)	97	96	77.47	69.75	41.97	34.07	93	76	31.58	35.07	72.35	77.94	24.34	25.05
KRL 19 (BW)	98	96	81.30	49.27	46.00	36.46	154	64	36.85	36.87	102.84	70.31	30.45	22.89
UAS 304 (BW)	97	94	82.66	89.14	46.94	42.24	64	92	35.89	30.75	130.44	61.29	27.41	21.37
UAS 334 (BW)	100	97	78.89	62.76	44.72	39.15	75	79	34.40	31.01	115.69	86.41	37.94	32.29
UAS 428 (DW)	103	102	95.72	84.50	39.95	34.95	140	71	35.71	35.02	107.84	91.15	15.26	19.19
DDK 1029 (DiW)	103	103	91.32	81.60	44.96	39.35	81	49	38.19	36.92	93.01	47.20	32.90	13.99
HD 2009 (BW)	99	97	73.19	68.27	49.89	43.54	113	91	32.33	28.99	119.86	85.62	29.03	19.06
Kharchia 65 (BW)	98	100	99.86	79.77	48.15	34.63	123	85	29.28	28.49	110.82	64.18	24.55	22.99
KRL 3-4 (BW)	103	102	91.35	64.44	45.33	42.42	109	103	33.57	31.95	83.02	79.03	32.15	28.05
IC 0408331 (BW)	104	101	94.78	60.90	45.02	40.34	107	82	41.57	39.31	71.35	74.82	30.06	26.81

Table 4. Mean performance of wheat genotypes under saline and control condition of *rabi* 2021-22 at Ugar Khurd

Genotype	DM		PH		SPAD		TPM		TGW		BM		GY	
	C	S	C	S	C	S	C	S	C	S	C	S	C	S
UAS BW-13892	96	91	92.11	73.42	54.56	40.53	123	60	39.57	41.85	89.34	121.07	51.26	29.19
DIC-101	109	109	87.91	89.16	45.12	32.74	147	167	32.49	34.72	105.64	65.16	47.38	34.98
DIC-107	109	108	95.98	90.18	39.81	45.18	111	106	35.95	33.86	146.28	82.91	48.00	26.86
KRL 210 (BW)	96	95	75.85	68.72	41.74	34.08	90	80	32.01	33.89	68.18	79.55	22.33	22.60
KRL 19 (BW)	98	97	79.98	64.84	45.74	35.85	154	66	36.33	35.49	99.31	69.66	28.33	20.95
UAS 304 (BW)	96	94	81.64	89.06	45.94	45.04	62	97	36.22	29.70	128.63	61.66	27.82	19.29
UAS 334 (BW)	98	96	78.18	59.86	42.36	36.98	73	80	35.12	30.45	114.00	87.75	38.77	32.33
UAS 428 (DW)	101	100	93.57	80.63	39.06	35.29	140	69	36.99	34.52	109.77	91.80	27.36	16.13
DDK 1029 (DiW)	103	103	91.85	80.90	43.53	39.34	80	48	36.80	35.46	89.59	47.42	34.26	9.62
HD 2009 (BW)	96	96	74.79	64.97	50.81	42.83	111	91	31.10	28.35	118.84	87.50	27.53	18.66
Kharchia 65 (BW)	99	98	99.26	78.09	46.90	33.85	124	89	28.03	26.91	106.38	64.06	22.79	20.81
KRL 3-4 (BW)	101	100	90.77	59.84	43.92	42.36	105	104	34.41	32.74	79.77	77.63	31.25	25.77
IC 0408331 (BW)	102	102	94.12	60.77	44.15	39.26	105	84	42.03	40.00	72.85	76.61	29.87	24.62

Table 5. Mean performance of wheat genotypes under saline and control condition of *rabi* 2022-23 at Ugar Khurd

Genotype	DM		PH		SPAD		TPM		TGW		BM		GY	
	C	S	C	S	C	S	C	S	C	S	C	S	C	S
UAS BW-13892	97	92	90.71	76.17	57.04	41.81	121	82	40.73	40.71	83.46	106.46	49.31	32.36
DIC-101	111	109	87.29	88.31	46.89	32.48	146	169	34.07	35.17	100.06	83.44	48.81	31.81
DIC-107	108	107	95.62	91.36	41.81	46.89	114	99	36.36	35.82	148.37	94.38	49.32	31.36
KRL 210 (BW)	95	95	76.65	66.82	41.35	31.21	88	85	29.90	36.95	83.44	83.33	28.81	29.81
KRL 19 (BW)	97	99	80.74	62.83	43.74	33.36	146	69	34.93	34.93	101.00	77.86	28.48	19.74
UAS 304 (BW)	99	94	81.29	87.29	43.33	43.74	82	95	36.28	29.79	123.39	85.77	31.36	21.36
UAS 334 (BW)	99	97	77.02	61.31	42.16	36.32	79	81	35.17	33.02	111.89	85.38	50.72	32.36
UAS 428 (DW)	103	101	92.17	80.46	40.71	34.65	147	69	36.58	33.60	121.07	98.87	29.76	21.31
DDK 1029 (DiW)	106	103	93.33	80.74	41.69	40.71	81	49	34.53	34.26	98.87	54.37	31.81	18.74
HD 2009 (BW)	99	95	76.17	64.81	51.26	41.69	117	91	33.02	29.90	106.46	83.46	29.35	19.76
Kharchia 65 (BW)	101	97	98.03	79.74	47.28	34.82	121	86	29.90	29.90	103.03	83.44	29.81	22.36
KRL 3-4 (BW)	102	103	91.36	59.97	41.69	41.35	99	103	36.95	29.90	83.33	79.38	27.71	29.76
IC 0408331 (BW)	103	106	95.18	59.00	42.79	36.98	103	88	40.71	40.73	82.98	77.98	32.36	22.88

Table 6. Mean performance of wheat genotypes under saline and control condition of *rabi* 2023-24 at Ugar Khurd

Genotype	DM		PH		SPAD		TPM		TGW		BM		GY	
	C	S	C	S	C	S	C	S	C	S	C	S	C	S
UAS BW-13892	96	90	94.59	72.74	55.69	38.36	124	81	40.26	41.86	91.72	115.00	56.69	27.26
DIC-101	110	107	88.76	87.04	45.36	31.26	149	167	33.44	34.64	108.54	93.80	56.45	29.86
DIC-107	109	111	94.51	92.87	38.36	45.36	120	105	36.68	35.17	161.22	97.86	45.74	32.24
KRL 210 (BW)	96	95	75.30	67.66	44.34	35.67	90	88	33.22	34.97	93.80	85.61	32.91	29.65
KRL 19 (BW)	97	95	77.51	63.89	47.36	36.39	140	69	36.20	36.20	94.36	75.38	31.38	23.38
UAS 304 (BW)	96	95	82.33	88.76	41.29	47.36	81	91	37.21	32.36	125.74	69.87	32.24	33.52
UAS 334 (BW)	98	96	79.78	59.96	40.78	37.16	72	78	34.64	28.31	114.88	96.87	48.28	27.26
UAS 428 (DW)	100	98	92.88	80.54	36.39	36.45	139	68	35.09	36.22	111.01	100.05	32.33	19.31
DDK 1029 (DiW)	102	101	92.29	77.51	45.59	36.39	78	50	35.33	36.95	100.05	56.88	29.86	15.31
HD 2009 (BW)	96	96	72.74	66.83	52.26	45.59	113	90	28.31	31.72	115.00	91.72	36.24	21.37
Kharchia 65 (BW)	97	97	100.22	76.16	49.36	34.79	119	89	29.48	29.48	103.67	93.80	29.65	20.31
KRL 3-4 (BW)	100	100	92.87	61.88	44.27	44.34	105	100	34.97	33.22	85.61	79.53	28.69	32.33
IC 0408331 (BW)	101	102	93.74	61.80	44.12	33.64	100	81	41.86	40.26	81.98	80.88	27.26	24.17

number of tillers per meter row under both saline (163 to 169) and control (146 to 150) conditions. On the other hand, the genotype GPM DIC 107 recorded the highest biomass under control conditions (143 to 161 q/ha) and was the tallest among the three genotypes. The mean grain yield of UAS BW-13892 ranged from 47.86 to 56.69 q/ha under control conditions and from 27.26 to 32.36 q/ha under saline conditions across the four years. GPM DIC 101 recorded grain yields ranging between 47.38 and 56.45 q/ha (control) and 27.86 to 34.98 q/ha (saline), while GPM DIC 107 recorded 45.74 to 49.32 q/ha (control) and 26.51 to 32.24 q/ha (saline). All three genotypes consistently outperformed the sensitive checks (UAS 304, UAS 334, UAS 428, DDK 1029 and HD 2009) and produced yields comparable to, or in some cases better than, the released salt-tolerant cultivars (KRL 210, KRL 19 and KRL 3-4). Comparable means were observed by Rashmi and Suma, 2018; Kirankumar *et al*, and Biradar *et al*, 2024 for various growth and yield traits in wheat.

Wheat growth parameters are considered key indicators of cultivar potential in terms of stress tolerance and adaptability (Omrani, 2022). In the present investigation, the high salt concentration in soil adversely affected vegetative growth, as reflected in the mean performance of the different traits under stress conditions. In general, there was an overall reduction in crop growth duration under salinity, as indicated by the mean values for days to maturity. Most of the yield and yield-attributing traits, such as number of tillers per meter row and grain yield, were significantly affected under saline conditions and showed a drastic reduction in mean performance. Further, due to reduced crop growth, plant height and tillering ability manifested a significant decline in biomass accumulation. The trait thousand-grain weight was, however, least affected, probably due to the compensatory effect resulting from the reduced number of tillers per meter. Similar observations were made by Dadshani *et al.* (2019), who reported that grain yield and tiller number decreased in saline soils in spring wheat. Likewise, Kumar *et al.* (2014), in their study on seven wheat varieties, reported that yield and yield components (*i.e.*, 1000-grain weight and spikes per m^2) were significantly reduced under saline water irrigation.

Among the physiological traits, chlorophyll content was higher under control conditions. Under salinity stress, plants face an energy crisis wherein the photosynthetic capacity of the plant is no longer sufficient to meet the carbohydrate demand of developing leaves, ultimately reducing their growth (Munns and Tester, 2008). Differences in chlorophyll concentration and stomatal behavior have been observed between salt-affected and non-stressed wheat plants (Abdehpour and Ehsanzadeh, 2019). When the salt concentration of the soil solution increases, water potential declines, leading to reduced turgor in plant cells, which eventually ceases cell expansion. Moreover, specific ion toxicity occurs as a result of uptake and accumulation of sodium, chloride and sulfate ions from irrigation water. These ions are accumulated in the lower leaves of the plant, leading to premature wilting and senescence of lower leaves. This phenomenon is referred to as organ-level compartmentalization of toxic ions (Vahdati and Lotfi, 2013).

A common starting point for identifying promising genotypes for stress conditions is the relative yield performance of genotypes under both stress and favorable environments (Al-Ashkar *et al.*, 2022). Several methods have been proposed to evaluate genotype yield stability across diverse environmental conditions, as well as to select genotypes suited to both environments (Ehdale *et al.*, 1988; Falconer, 1990; Fernandez, 1992). In the present investigation, the three genotypes UAS BW-13892, GPM DIC 101 and GPM DIC 107 were classified as tolerant based on Stress Tolerance Index (STI) and Stress Susceptibility Index (SSI). These findings were confirmed from results of *rabi* 2020–21 under both natural saline soils and hydroponic screening with three salinity levels (Malipatil *et al.*, 2022; Malipatil *et al.*, 2023a; Malipatil *et al.*, 2025). These three genotypes were identified as the most promising, high-yielding and stable under salt stress conditions across four consecutive seasons (*rabi* 2020-21 to 2023-24).

The salt tolerance of UAS BW-13892 was mainly attributed to its ability to produce high biomass, attain early maturity and maintain a nearly stable thousand-grain weight even under saline stress. The tolerance of GPM DIC 101 was associated with its prolific tillering capacity, shorter stature and consistent performance in both thousand-grain weight and total biomass under saline conditions. In the case of GPM DIC 107, tolerance was attributed to strong early seedling vigor, sustained chlorophyll content under salinity stress and the absence of negative effects of stress on thousand-grain weight and tiller number per meter row.

Conclusion

The present study demonstrated significant genetic variability among wheat genotypes for salinity tolerance, growth and yield-related traits under both saline and control conditions. The consistent performance of UAS BW 13892, GPM DIC 101 and GPM DIC 107 across four consecutive seasons confirmed their stability and adaptability to saline environments.

UAS BW 13892 exhibited superior biomass accumulation and early maturity, GPM DIC 101 showed prolific tillering and shorter stature, while GPM DIC 107 maintained high chlorophyll content and vigor under stress. These complementary traits underline the diverse mechanisms contributing to salinity tolerance in wheat. The genotypes also outperformed sensitive checks and performed on par with established salt-tolerant varieties, highlighting their potential for use in breeding programs aimed at improving wheat productivity in salt-affected areas. Overall, the results emphasize the effectiveness of integrating field and hydroponic screening with stress indices for identifying robust salt-tolerant genotypes suitable for sustainable wheat production under saline conditions.

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