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Research Article

Studies on genetic variability parameters and character association in bread wheat (*Triticum aestivum* L.) under timely and late sown environments of irrigated condition

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Abstract
Sixteen diverse bread wheat genotypes studied at Agharkar Research Institute, Pune (Hol Farm) during *rabi* season of 2016-17. The present study revealed that the mean sum of squares due to genotypes was recorded significant for all the traits studied except grain yield per plot and harvest index in timely and late sown condition. The treatment versus genotype found significant among the traits days to heading and biomass per plot. The estimates of GCV, PCV, heritability and genetic advance were high to moderate in both conditions for the days to heading, productive tillers per meter, TGW, grain per spike, grain weight per spike, biomass per plot and grain yield per plot. Correlation coefficient reveled that, biomass per plot, productive tiller per meter, days to maturity gave the positive association with grain yield per plot in both the environments. One genotype was tolerant to grain yield per plot *viz*., HD 3219 (TS = 1052, LS = 934) under timely sown and late sown environments. It has been found that wheat genotypes differ their ability to respond to heat, there by tolerance, which could be useful as a genetic stock to develop wheat tolerant genotypes in wheat.

Keywords
Bread wheat, heritability, genetic advance, association

Introduction

Bread wheat (*Triticum aestivum* L.) is an important *rabi* season crop of India and Maharashtra with 30.23 m ha and 6.29 lakh ha, of area under wheat cultivation respectively. Productivity of Maharashtra recorded 12.05 q/ha and 30.93 q/ha of India (Anon., 2016). Wheat is an important cereal grain for export and domestic consumption in many countries throughout the world. Thus, continuous supply of wheat to exponentially increasing population is a major concern. The modern wheat breeding programmes focus on the improvement of agronomic and grain quality traits. The manipulation of wheat genetics has led to ever-increasing gains in yield and grain quality, while decreasing the ability of wheat to survive in the wild or varying climate especially with adverse condition. The ultimate aim of plant breeding programme is to develop cultivars with high potential and consistent performance over diverse environments. Wheat crop is sensitive to different abiotic stresses at almost all growth stages. The optimum range of temperature for growth stages is 18-24^{0}C. Temperature beyond this range even for short period of 5-6 days causes 20% or more yield losses in wheat (Stone and Nicolas, 1994). Thermal stress due to rising ambient temperature during grain growth is one of the major constraints in enhancing wheat productivity particularly when the crop is sown late because of delayed harvesting of previous crops. Recently climate change has increased the risks of exposure to higher temperature by manifold even for timely sown wheat. Each degree rise in temperature causes 3-4% reduction in grain weight as reveled by studies under controlled and natural environments. The total wheat production in the country may get reduced at least 4 million tones any given year for each degree rise in ambient temperature. In general, the reduction in grain yield due to late sowing ranges from 25-35% depending on extent of delay and climatic conditions. In 2002-03, due to sudden increase in temperature during grain development stage, there was 9% reduction in total wheat production in India (Tiwari *et al*., 2014). The heat stress tolerance in wheat research, at natural field condition is mostly studied by the comparative analysis of timely and late sown condition with the facilitation of either regular irrigation or restricted irrigation. Late sown irrigated (sowing after 1st December) wheat crop expose to high temperature

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during flowering and grain filling stages as compared to timely sown irrigated (sowing during 1st to 15th November) crop, this could be one of the reason for lower productivity of the state. Grain yield is a complex trait and highly influenced by many genetic factors and environmental fluctuations. In plant, breeding programme direct selection for yield as such could be misleading. A successful selection depends upon the information on the genetic variability and association of agronomic traits with grain yield. Hence, the present experiment was undertaken to study the genetic variability parameters and characters association under timely sown (non-heat stress) and late sown (heat stress) condition to identify important traits to heat stresses that have better performance in environments with heat stress intensities. The material information out of the present experiment will also being used to study further for physiological traits and stress tolerant indices to effective identification of heat tolerant genotypes. The suitable cultivars will then be used in wheat breeding programmes for development of genotypes adapted to heat stress conditions in the target environment.

Materials and Methods

The experiment consists of 16 bread wheat (*Triticum aestivum* L.) genotypes (varieties/lines) received from IIWBR as a part of the multi-location trial to evaluate under timely and late sown environments. The details of source of selected genotypes were given in Table 1.

The seeds of 16 genotypes were timely sown on 16th November and late sown on 12th December, 2016 during crop current season in Randomized Completely Block Design (RCBD) with two replications. The plot size was 3 m x 6 rows with spacing of 23 cm between the rows. Fertilizers were applied @ 90:60:40 NPK kg/ha for timely and late sown conditions, respectively. The rest of the field operation and post-harvest processing was done timely.

The experiment was conducted at the Experimental Research Farm, Hol, Agharkar Research Institute, Pune during *rabi* 2016-17. The research farm is located at $18^0$04'N; $74^0$21'E; 549 m above sea level at Hol, Baramati, Pune district, India. The precipitation and average temperature for the 2016-17 cropping season at research farm were presented in Table 2.

Observation were taken from 5 randomly selected plants on plant height (PH), and rest traits were measured based on their required dimension viz., productive tiller per meter (PTM), grains per spike (GN. SP), 1000-grain weight (g) (TGW), biomass per plot (BIOM), harvest index (HI) and grain yield per plot (GW). The analysis of variance was performed by using STAR (IRRI) software. The test of significance done by F test. Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were estimated according to Burton and Devane (1953), heritability in broad sense; genetic advance was calculated following Hanson *et. al*., (1956) and the correlation coefficient were estimated according to Al-Jibouri *et al*., (1958).

Both genotypic and phenotypic coefficients of variability were computed as per the method suggested by Burton and Devane (1953).

The heritability was categorized as low, moderate and high as given by Robinson et al. (1949). It is as follows, 0-30% (low); 30-60% (moderate); 60% and above (high).

The extent of genetic advance to be expected from selecting five per cent of the superior progeny was calculated by using the following as described by Johnson et al. (1955):

$GA = K (\sigma_p) h^2$,

where: K = the selection differential (K = 2.06 at 5% selection intensity);

σ_p = the phenotypic standard deviation of the character;

h^2 = broad sense heritability.

The value of K was taken as 2.06 assuming 5% selection intensity.

Genetic advance over mean was estimated using the following formula,

$$GAM (\%) = \frac{GA}{\bar{X}} \times 100$$

Genetic advance as per cent mean was categorized as low, moderate and high as given by Johnson *et al*. (1955). It is as follows, It is as follows, 0-10% (low); 10-20% (moderate); 20% and above (high).

Results and Discussion

The mean value for all the traits under TS (Timely sown) environment were high compared to LS (Late sown) environment. (Table 3) The mean values for grain yield per plot showed a wide variation which ranged from 920 (TS-HD 3219) to 1527 (TS-DBW 187) and 726 (HI 1617) to 1023 (LS-DBW 196) with mean value of 1231.44 gm (TS) and 863.44 gm (LS).

Biomass per plot ranged from 2890 (TS -DBW 14) to 4920 (TS-HD 2932) and 2002 (LS -UP 2942) to (LS -DBW 196) with mean value of 38.65.62 gm (TS) and 2434.88 gm (LS). Productive tillers per meter was ranged from 68.00 (TS -UP 2942) to 124.00 (TS-HD 3226) and 58 (LS-DBW 189) to 113 (LS-WH 1202) with a mean.

The results from combined analysis of variance in timely and late sown conditions for the various traits are presented in Table 4. The present study revealed that the mean sum of squares due to genotypes was recorded significant (*, ** at 5 % and 1 % probability level, respectively) for all the traits studied except grain yield per plot and harvest index in timely and late sown condition. The treatment versus genotype found significant among the traits days to heading and biomass per plot, hence these traits were critical among the genotypes for the time of sowing and weather parameters.

The estimates of GCV were moderate to high for days to heading (10.10), productive tillers per meter (15.20), grain per spike (19.89), grain weight per spike (17.49) and biomass per plot (12.22). The PCV values were higher than GCV values for all the traits for both the condition (TS and LS). which reflects the influence of environment on the expression of all the traits, similar results were reported by Singh *et al*., (2012).

The genotypic coefficient of variation along with estimate of heritability in broad sense provide bonafide estimates of the amount of genetic advance to be expected through phenotypic selection (Burton, 1952). The estimate of heritability in broad sense were recorded high for days to heading (99.39), days to maturity (97.03), reproductive period (93.05), plant height (97.42), productive tiller per meter (79.26), TGW (97.11), grain per spike (85.53), grain weight per spike (83.20), biomass per plot (86.73) and grain yield per plot (77.08) (Table 5). Moderate heritability was estimate for harvest index (50.16). High heritability were also calculated and reported by Riaz-Ud-Din, *et al* 2010; Adewale *et al*., 2010; Rahim et al., 2010, for days to heading, days to maturity, reproductive period, plant height, productive tiller per meter, TGW, grain per spike, grain weight per spike, biomass per plot and grain yield per plot.

Genetic advance expressed as a per cent mean (Table 5) was the high for days to heading (20.82), productive tillers per meter (31.32), TGW (20.61), grain per spike (40.99), grain weight per spike (36.04) and biomass per plot (25.19). From the above discussion in timely sown and late sown conditions for days to heading, productive tillers per meter, TGW, grain per spike, grain weight per spike and biomass per plot showed ample genetic variance, high to moderate genetic gain. Therefore, selection can be based on these traits in both environments. The estimate of genetic advance is more useful as a selection tool when considered jointly with heritability estimate (Johnson *et al.,* 1955). High heritability with high genetic advance for day to heading, productive tillers per meter, grains per spike, grain weight per spike, TGW and biomass per plot indicates that most likely the heritability is due to additive gene effects and selection may be effective in early generation for these traits. Similar findings have been reported by Munir *et al*., (2007).

In the present investigation (Table 6) grain yield per plot was significantly and positively correlated with biomass per plot in both sowing environments (TS and LS) and hence the breeding for increase in biomass in both the sowing environments would be relevant to increase in the grain yield per plot. Grains per spike is an important yield contributing traits, which found positive significant correlation with grain weight per spike in both the TS and LS environments and with days to heading in TS condition (Talebi and fayyaz, 2012)**.** Reproductive period is very much sensitive to temperature and water availability, hence date of sowing is important for coincidence of the reproductive period with the congenial temperature range. In the present study, the reproductive period has shown significant negative correlation with days to heading, plant height, grain weight per spike in the timely sown environment. While no significant correlation in late sown environment with the same traits. Over all from the present investigation, it is found that the days to heading, days to maturity, grain per spike and biomass per plot are important traits to for yield improvement in late sown environments, since these traits had shown significant positive correlation either directly with grain yield or with yield contributing traits. Similar results obtained by Masood *et al*., (2014).

Least significant difference (LSD) test over both the environments, TS and LS with non-significant groups (genotypes) considered to be heat tolerant in each respective trait. The Two genotypes were found tolerant to days to heading *viz*., DBW 14 (TS = 56.0, LS = 56.0), RAJ 3765 (TS = 56.0, LS = 55.0), three were tolerant to reproductive period *viz.*, DBW187

(TS = 38.5, LS = 36.5), HP 1963 (TS = 35.5, LS = 34.0), WH 730 (TS = 38.0, LS = 36.5), five were tolerant to plant height (cm) *viz.* DBW 14 (TS = 84.5, LS = 83.5), HI 1617(TS = 98.5, LS = 95.5), PBW750 (TS = 103, LS = 100), RAJ 3765 (TS = 94.5, LS = 93.5), WH 730 (TS = 106.0, LS = 103.0) and interestingly, one genotype HD 3219 (TS = 1052, LS = 934) was found tolerant to grain yield per plot viz., under timely and late sown conditions. It is found to be suggested that wheat genotypes differ in their ability to respond to heat, there by tolerance, which could be useful as a genetic stock to develop wheat tolerant genotypes in wheat.

The analysis of variance for different characters indicated the prevalence of enough genetic variability in the genotypes for selection and improvement. Association study revealed that biomass per plot, productive tiller per meter, days to maturity had the positive association with grain yield per plot in both environments. These traits were the key contributors to yield per plant suggesting the need of more emphasis on these components for increasing the grain yield in wheat. In timely and late sown conditions grain per spike, grain weight per spike, productive tillers per meter, biomass per plot and grain yield per plot recorded high heritability and high genetic gain. Therefore, selection can be done based on these traits in both environments. The findings suggest that wheat genotypes are found to differ in their ability to respond to heat, there by tolerance, which could be useful as a genetic stock to developed bread wheat tolerance to hunt stress.

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References

Al-Jibouri, H.A., Miller, P.A. and Robinson, H.F. 1958. Genotypic and environmental variances in upland cotton cross of interspecific origin. *Agron. J.*, **50**: 633-635.

Adewale *et al*., 2010; Genotypic variability and stability of some grain yield components of Cowpea. Afr. J. Agric. Res. **5**(9):874-880.

Anonymous, 2016, 3rd Advance Estimates (2015-16) from the directorate of Economics and Statistics (DES), Ministry of Agriculture and farmers Welfare (MoA and FW), India.

Burton, G.W., and Devane, E.H. 1953. Estimating heritability in table fercue from replicating clonal material. *Agron J*. **45**: 45-481.

Hanson, G.H., Robinson, H.F. and Comstock, R.E. 1956. Biometrical studies on yield in segregating populations of Korean Lespidiza. *Agorn. J*. **48**: 268-272.

Johnson, H.W., Robinson, H.F. and Comstock, R.E. 1955. Estimation of genetic and environmental variability in soybean. *Agron J*. **47**: 314-318.

Kumar, N., Markar, S. and Kumar, V. 2014. Studies on heritability and genetic advance estimates in timely sown bread wheat (*Triticum aestivum* L.). *Bioscience Discovery*, **5**(1): 64-69.

Maqbool R, Sajjad, M. and Khaliq, I. 2010. Morphological diversity and traits association in bread wheat (*Triticum aestivum* L.). *American-Eurasian J. Agric. Environ. Sci*.,**8** (2): 216- 224.

Masood, S.A., S. Ahmad, M. Kashif and Q. Ali. 2014. Correlation analysis for grain and its contributing traits in wheat (*Triticum aestivum* L.). *Nat. Sci.* **12**(11): 168-176.

Munir, D., Chowdhry, M. A. and Malik, T. A. 2007. Correlation studies among yield and its components in bread wheat under drought conditions. *Int. J. Agril. Biol.*, **9**: 287–290.

Radhu, A. S., Solanki, S. K. and Singh, I. 1995. Genetic diversity in some Indian and exotic wheat varieties. *Crop Improvement*, **22**(2): 214-217.

Rahim *et al.*, 2010, Genetic variability, character association and genetic divergence in Mungbean (Vigna radiataL. Wilczek). POJ. **3**(1):1-6

Riaz-Ud-Din, *et al* 2010; Effect of temperature on development and grain formation in spring wheat. Pak. J. Bot. **42**(2):899-906.

Robinson, H. F., Comstock, R. E. and Harvey, P. H. 1949. Genotypic and phenotypic correlations in corn and their implications in selection. *Agron. J.* **43**: 282-287.

Sivasubramanian, S. and Menon, M. 1973. Heterosis and inbreeding depression in rice. Madras *Agric. J.* **60**: 1139.

Stone, P. J. and Nicholas, M. E. 1994. Wheat cultivars vary widely in their responses of grain yield and quality to short periods of postanthesis heat stress. *Aust. J. Plant Physiol*. **21**: 887-900.

Tiwari, R., Sheoranand, S., and Rane, J. 2014. Wheat improvement for drought and he at tolerance. DWR, Karnal, India and NIASM, Maharashtra, India.

Table 1. List of bread wheat genotypes used in the study

Sr. No.	Name of the Genotype	Parentage	Developed by/Source
1	WH 1202	D67.2/PARANA66.270//AE.SQ.(320)/3/CUNNINGHAM	CCSHAU, Hisar
2	DBW 196	ROLF07*2/KACHU#1	IIWBR, Karnal
3	HP 1963	FRET2/TUKURU//FRET2/3/MUNIA/CHTO//AMSEL/4/FRET2/TUKURU//FRET2	Pusa, IARI,RS
4	Raj 3765	HD 2402/VL639	SKNAU, Durgapura
5	PBW 752	PBW621/4/PBW343//YR10/6*AVOCET/3/3*PBW343/5/PBW621	PAU, Ludhiana
6	HD 2932	KAUZ/STAR//HD 2643	IARI, New Delhi
7	UP 2942	CS/TH.SC//3*PVN/3/MIRLO/BUC/4/URES/JUN//KAUZ/5/HUITES/6/YANAC/7/CS/TH.SC//3*PVN/3/MIRLO/BUC/4/MILAN/5/TILHI	Pantanagar, GBPUAT
8	PBW 750	TOB/ERA//TOB/CNO67/3/PLO/4/VEE#5/5/KAUZ/6/FRET2/7/PASTOR//MILAN/ KAUZ/3/BAV92	PAU, Ludhiana
9	DBW 14	RAJ 3765/PBW 343	IIWBR, Karnal
10	HD 3226	GRACKLE/HD2894	IARI, New Delhi
11	DBW 71	PRINIA/UP2425	IIWBR, Karnal
12	DBW 187	NAC/TH.AC//3*PVN/3/MIRLO/BUC/4/2*PASTOR/5/KACHU/6/KACHU	IIWBR, Karnal
13	DBW 189	KACHU#1/4/CROC_1/AE.SQUARROSA(205)//BORL95/3/2*MILAN/5/KACHU	IIWBR, Karnal
14	WH 730	CPAN2092/ Improved. LOK1	CCSHAU, Hisar
15	HI 1617	BAJ#1*2/HUIRIVIS#1	Indore, IARI, RS
16	HD 3219	PBW343/HD2879	IARI, New Delhi

Table 2. Temperature and rainfall during wheat cropping season 2016-17 (Source: Agro-Metrological Observatory, Unit MACS-ARI, Hol farm

Month	Temperature ^{0} C		Rainfall (mm)	Relative humidity (%)	
	Min.	Max.		Min.	Max.
November	12.3	30.7	0.0	38.4	64.7
December	10.5	29.7	0.0	47.2	71.1
January	10.3	29.6	0.0	40.5	67.4
February	12.8	33.2	0.0	36.3	62.8
March	15.0	35.8	0.0	27.2	53.8
April	18.0	38.0	0.0	20.2	45.0
Average	**13.1**	**32.8**	**0.0**	**34.9**	**60.8**

Table 3. Mean and range for various traits under timely and late sown environments in bread wheat

Variability parameter	Mean		Range	
	TS (Timely sown)	LS (Late sown)	TS	LS
DH	64.72	60.91	56 - 72	55-68
DM	104.25	96.78	99 - 113	91-104
RP	39.53	35.88	35 - 45	32-41
PH (cm)	98.53	93.34	84 - 108	82-103
PTM (m)	96.59	77.12	68 - 124	58-113
TGW(gm)	39.75	37.88	33 - 46	34-45
GN. SP	50.44	47.59	33 - 71	34-63
GW. Sp (gm)	2.21	1.99	1.5 - 2.9	1.4-2.8
BIOM (gm)	3865.62	2434.88	2890.00 – 4920.00	2002.00-3090.00
GW (gm)	1231.44	863.44	920 - 1527	726-1023
HI (%)	32.04	35.50	28.0 - 36.5	31.7-38.7

DH = Days to heading, DM = Days to maturity, RP = Reproductive period, PH = Plant height (cm), PTM (m) = Productive tillers per meter, TGW (g) = 1000 grain wt. (g), GN. SP = Grain per spike, GW. Sp = Grain weight per spike (g), BIOM = Biomass per plot (g), GW = Grain yield per plot (g), HI = Harvest index (%).

Table 4. Pooled analysis of variance for different characters under timely sown and late sown environments in bread wheat

Source	DF	DH	DM	RP	PH (cm)	PTM (m)	TGW (g)	GN. SP	GW. Sp (g)	BIOM (g)	GW (g)	HI (%)
Rep.	1	0.56	0.77	0.02	1.56	129.39	1.56	0.14	0.00	17556.25	23562.25	6.70
Treatment	1	232.56**	892.51**	213.89*	430.56*	6064.52	56.25	129.39	0.74	32752729**	2166784**	191.48
Genotype	15	81.11**	45.51**	18.50**	109.48**	451.99*	31.05**	231.51**	0.33*	345668.13**	22305.68	5.77
Treatment : Genotype	15	2.82**	2.34	2.95	7.79	91.44	1.45	20.22	0.03	284024.86**	19046.30	4.39
Error	31	0.49	1.37	1.33	2.85	103.16	0.91	41.20	0.06	48864.63	5679.02	3.45

*, ** significant at 0.05 and 0.01 probability level respectively.

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Table 5 . Genetic variability parameters obtained from combined analysis for various traits under timely and late sown environments in bread wheat

Variability parameter	PV	GV	PCV (%)	GCV (%)	Heritability (bs) (%)	G. A. as a (%)
DH	40.8	40.31	10.16	10.10	99.39	20.82
DM	23.44	22.07	4.81	4.67	97.03	9.63
RP	9.91	8.58	8.35	7.77	93.05	16.01
PH (cm)	56.16	53.31	7.81	7.61	97.42	15.68
PTM (m)	277.57	174.41	19.18	15.20	79.26	31.32
TGW(g)	15.98	15.07	10.30	10.00	97.11	20.61
GN. SP	136.35	95.15	23.82	19.89	83.53	40.99
GW. Sp (gm)	0.19	0.13	21.02	17.49	83.20	36.04
BIOM (gm)	197266.38	148401.75	14.09	12.22	86.73	25.19
GW (gm)	13992.35	8313.33	11.29	8.70	77.08	17.93
HI (%)	4.61	1.16	6.35	3.18	50.16	6.57

DH = Days to heading, DM = Days to maturity, RP = Reproductive period, PH (cm) = Plant height (cm), PTM (m) = Productive tillers per meter, TGW (g) = 1000 grain wt. (gm), GN. SP = Grain per spike, GW. Sp = Grain weight per spike (gm), BIOM = Biomass per plot (gm), GW = Grain yield per plot (gm), HI = Harvest index (%).

Table 6. Correlation for various traits under timely sown and late sown environments in bread wheat

Character	Environment	DH	DM	RP	PH (cm)	PTM (m)	TGW (g)	GN. SP	GW. Sp (g)	BIOM (g)	GW (g)	HI (%)
DH	TS LS	1	0.8669** 0.8323**	-0.7311** -0.5000	0.4435 0.2144	-0.2639 0.0496	-0.4347 -0.2442	0.5885* 0.4147	0.5644* 0.4321	-0.1103 0.5768*	-0.2188 0.5076	-0.1572 -0.1932
DM	TS LS		1	-0.2937 0.0639	0.2260 0.1296	-0.2354 0.0474	-0.3286 -0.2172	0.4701 0.3026	0.4075 0.3850	-0.1668 0.5317*	-0.3141 0.4222	-0.1880 -0.2851
RP	TS LS			1	-0.5413* -0.1836	0.1836 -0.0152	0.3838 0.1002	-0.4851 -0.2738	-0.5247* -0.1765	-0.0168 -0.2078	-0.0103 -0.2543	0.0442 -0.0975
PH (cm)	TS LS				1	-0.1202 -0.0586	-0.2445 -0.0929	0.4975 0.2545	0.5635* 0.2936	0.1999 0.2517	0.1804 0.1588	-0.1389 -0.2577
PTM (m)	TS LS					1	-0.3252 -0.2154	-0.3354 -0.2020	-0.3614 -0.3514	0.3051 0.5120	0.2249 0.4440	-0.1943 -0.1960
TGW (g)	TS LS						1	-0.3619 -0.2631	-0.0984 0.1609	-0.2934 -0.4137	-0.0222 -0.3787	0.5292* 0.1459
GN. SP	TS LS							1	0.8089** 0.8512**	0.1928 0.1870	0.0422 0.2739	-0.2989 0.1708
GW. Sp (g)	TS LS								1	0.1846 0.0048	0.0812 0.0860	-0.2151 0.1859
BIOM (g)	TS LS									1	0.8246** 0.9035**	-0.5687* -0.3211
GW (g)	TS LS										1	-0.0094 0.1130
HI (%)	TS LS											1

*, ** significant at 0.05 and 0.01 probability level respectively. r = 0.521 at 0.05 %, r = 0.685 at 0.01 %
DH = Days to heading, DM = Days to maturity, RP = Reproductive period, PH = Plant height (cm), PTM (m) = Productive tillers per meter, TGW (g) = 1000 grain wt. (g), GN. SP = Grain per spike, GW. Sp = Grain weight per spike (g), BIOM = Biomass per plot (g), GW = Grain yield per plot (g), HI = Harvest index (%)