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Research Article

Agronomic performance of some alien bread wheat (*Triticum aestivum*) lines under agro-ecological conditions of Sakrand, Pakistan

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Abstract

Variation in plant traits is considered as drivers of species evolution and of a greatest importance to plant breeders. The selection of the exotic wheat cultivars for high yield and their resistance to rust disease is of prime importance nowadays, which in result reduces the environmental impact and the total cost of lethal fungicides. Present study keeping the importance in view was carried to evaluate seven exotic wheat genotypes received from CIMMYT, Mexico; which were then compared to two local wheat cultivars (control). Significant (p<0.05) differences between the genotypes and control wheat cultivars were documented in terms of yield, yield related traits and resistance to the leaf rust disease. Cultivar G-193 not only appeared with higher yield but also had lowest AUDPC%-days values, demonstrating its higher resistance to the rust diseases. The study hence concludes with strong recommendations for cultivation of Cultivar G-193 among other cultivars.

Keywords: AUDPC; bread wheat; leaf rust; yield

Introduction

Bread wheat *(Triticum aestivum* L.) a hexaploid species of family Poaceae is one of the highest cultivated cereal crops of the World. It is a staple food of human's daily diet associated with numerous health and nutritional benefits [1, 2]. Wheat is adaptable to different environmental and soil conditions, especially the temperate region [3, 4]. Pakistan though is ranked among top ten wheat producing countries, but it still faces low average yield to its potential yield.

The factors for the losses includes low agro-ecological performance of the cultivars and severe fungal and bacterial diseases [5]. Wheat leaf rust is a common fungal disease threating wheat production worldwide, causing huge losses of wheat landraces in Pakistan too. The pathogen associated with this disease belongs to genus *Puccinia* that causes low seed germination rate, slow plant growth, reduction of weight and ultimately low yield with great damage to the crop [6].

Several breeding programs are being conducted worldwide to increase yield and its quality; in addition of evaluating resistant or tolerant varieties to pest, pathogen problems and different biotic and abiotic stresses [7, 8]. The selection of genotypes with wide range of adaptability to different climatic conditions with more high yielding traits *i.e.* tillers per plant, spikelets per spike, number of grains per spike and grain weight per spike has an prime importance in carrying a successful wheat breeding program [1, 9. 10, 11]. The interest in cultivating the exotic cultivars under different agro-climatic conditions is developing as an important source of genetic variations as compared to local landraces (mixture of traditional crop varieties) often having low yield [12-14]. The current study keeping the importance in view was conducted to evaluate the agronomic performance of seven different exotic wheat cultivars originated in CIMMYT, Mexico under field conditions of Wheat Research Institute Sakrand, Sindh, Pakistan.

Materials and methods

Plant material

The field experiment was conducted at Wheat Research Institute (WRI), Sakrand, (26.1333^0 latitude and 68.2667^0 longitude) in Sindh province of Pakistan. The experimental plant material consisting of seven wheat genotypes *i.e.* G-186, G-187, G-188, G-189, G-191, G-192 and G-193 were acquired from CIMMYT (Mexico) by Institute of Plant Sciences, University of Sindh, Jamshoro, Pakistan. Morocco (Mrc) cultivar was used as a control for evaluating rust resistance, while Benazir (Benz) and TD-1 cultivars were used for the agro-morphological characteristics.

Experimental design

Wheat cultivars were sown in the month of November after proper seed bed preparation. The seeds were dropped in furrows by a funnel attached with an iron pipe in the hand of plough (pora/nai method) at a desired depth and spacing for obtaining satisfactory germination. The row to row space was kept at 9 inches. A total of forty-two wheat lines were evaluated for agronomic diversity and rust disease. The statistical design was subjected to randomized complete block design (RCBD), replicated thrice in favor of single crop season.

Morphological characteristics

The important morphological features *i.e.* plant height, leaf number, leaf length, leaf width, peduncle length, spike length and spikelet number of tested varieties were examined at the field throughout the growing conditions at appropriate growth and developmental stages of plants. The flag leaf area was calculated by separating the flag leaf blades using pointed reaper at flowering stage. Whereas, the germination percentage was measured using following formula:

$$\text{Germination (\%)} = \frac{\text{Seeds germinated}}{\text{Total seeds}} \times 100$$

Yield and Yield related characteristics

The yield and yield attributed features *i.e.* harvesting index, number of days to booting and heading, tiller number, ten grain weight, ten grains length, thousand grain weight and tiller number were recorded for each genotype and control cultivars as per following methods:

Days to booting and heading

The days to booting of the cultivars were counted when the sheath of the flag leaf appeared inflated for the duration of the booting stage due to the developing heads.

With the first awns emerging from the flag leaf sheath, the booting stage ends and the head establishes to force the sheath unwrap. The days to heading in wheat cultivars were counted since the appearance of the tilt of the head, as soon as the head could fully be seen not reaching to its flower stage.

1000-Grain Weight

To record 1000-grain weight, clean and intact grain samples were randomly collected from the hand threshed samples of spikes. Three samples of 1000-grains at a moisture of 15% were weighed separately using an electronic weight balance. The values were reported as the average of thrice [15].

Grain length and width

Size of grain in length and width were measured in centimeter by placing 10 seeds in a round.

Harvest index

The harvest index was calculated by dividing sum of grain production by the total plant yield. Here total plant production gets into description grain production. Therefore, economic yield / total plant yield offers harvest index.

Disease resistance

The rust disease reaction and severity percentage were observed through modified Cobb's scale as per Peterson *et al*. [16]. Host resistance is an outstanding means of controlling leaf rust, resistance restrictions infectivity, fungus development and spore development. Rust severity was estimated visually with three rounds. Resistance levels diverge amongst genotypes were classified as: R = resistant, MR = moderately resistant, MS = moderately susceptible and S = susceptible.

Statistical analysis

Data was statistically analyzed by using the statistical package MSTATC (Version 2.00) and least significant differences (LSD) test was applied to separate the means.

Results and discussion

Morphological characteristics

The results of ANOVA revealed significant differences ($p \leq 0.05$) for morphological, yield and yield related attributes and are in harmony with the results published by Baloch et al. [3], who observed considerable genetic variations regarding yield and its associated traits among 19 exotic wheat cultivars under agro-ecological condition of Tandojam, Sindh, Pakistan. The results for germination rate obtained resulted a significant differences ($p \leq 0.05$) among different tested wheat genotypes as compared to control cultivars (Figure 1). Benazir cv. appeared with highest germination rate (90.16%) followed by TD-1 (88.33%), G-192 (85.00%), G-188 (82.5%) and Mrc (81.66%). The lowest germination rate was recorded in cv. G-193 (74.16%) which was significantly different from control cultivars Benazir and TD-1. Though the germination rate was higher for the local cultivars, the cultivars *i.e.* G-192 and G-188 obtained from Mexico resulted similar and non-significant difference in terms of germination rate.

The results for morphological features are presented in (Table 1). The results revealed with a significant difference ($p \leq 0.05$) among them. Cv. Mrc appeared significantly different and had greater values in terms of plant height (102.27 cm). The significantly lowest plant height was recorded in cv. TD-1 (79.61 cm) that is in accordance with the results published by Arain et al. [17] who obtained more or less similar plant height of TD-1 (80.6 cm). The variations regarding plant height among different wheat cultivars under different agro-ecological conditions was also observed by Destro et al. [18]. The leaf number for wheat cultivars were almost similar however, cvs. G-188, G-191 and Mrc were revealed maximum average number of leaves with 4.66, followed by cv. TD-1 (4.33). In contrast, rest of the cultivars appeared significantly different with lower

leaf number than cv. G-188, G191 and Mrc. Flag leaf area has an important role in appropriate grain filling and development [19]. The maximum flag leaf area was recorded in cv. TD-1 (63.66) but was not significantly different to cvs. G-186 (60.59), Mrc (59.72) and Benz (59.68). The significantly lower flag leaf area was noticed in G-193 (34.38) which showed significantly different and lower values except from the cvs. G-189, G-192 and G-188.

A significant difference among the wheat cultivars was observed for days taken to booting and heading. Cv. G-191 took significantly different and had maximum days to booting (81.00 days) and days to heading (88.00 days) as compared to rest of the cultivars. Lowest number of days to booting (65.33 days) and days to heading (72.33 days) were observed for cv. TD-1. Similar findings regarding days taken to heading for cv. TD-1 (67 days) has been reported by Arain et al. [17] whom further stated that ears emergence is a key trait that governs the phenotypic nature of the wheat cultivars. The cvs. Mrc and G-186 resulted significantly different having maximum length of 39.39 cm and 38.69 cm peduncle respectively. The significantly lowest length of peduncle was observed for G-193 (31.00 cm). Whereas, for other cultivars, they were observed to be non-significant from each other.

Yield and Yield related characteristics

Statistically significant differences (p<0.000) were found among different tested wheat cultivars in terms of harvest index (Figure 2). The significantly highest harvest index was recorded in cvs. G-186 (51.53) and G-189 (50.95), whereas the lowest harvest index was significantly recorded for cv. G-193 (43.35). The cv. G-186 and G-189 bears a moderate plant height and showed a higher harvesting index. The current findings are in agreement with the results published by Destro et al. [18] that a semi-dwarf plant height is a positive trait for the harvest index of wheat crop.

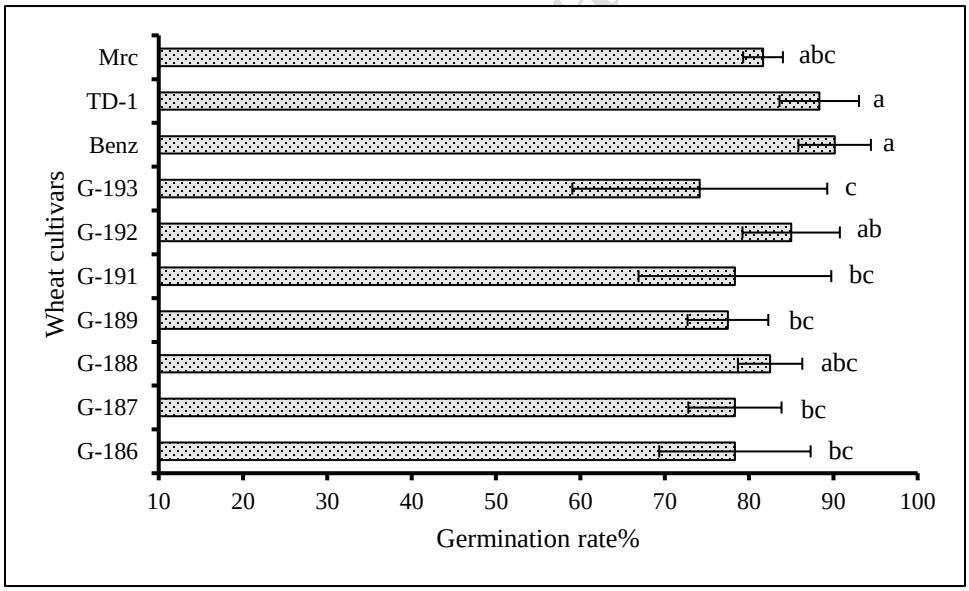

Figure 1. Germination rate of the tested wheat cultivars.

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Table 1. Morphological Characteristics the tested wheat cultivars

Cultivar	Plant Height (cm)	Leaf number	Flag Leaf area	Days to Booting	Days to Heading	Peduncle length (cm)
G-186	95.72^{cd}	4.00^{b}	60.59^{a}	73.00^{e}	79.66^{d}	38.69^{a}
G-187	92.72^{e}	4.00^{b}	49.01^{b}	78.00^{b}	85.00^{b}	34.55^{b}
G-188	97.5^{bc}	4.66^{a}	39.52^{cd}	69.00^{f}	78.00^{e}	34.5^{b}
G-189	94.83^{de}	4.00^{b}	35.85^{d}	73.00^{e}	79.00^{de}	34.27^{b}
G-191	93.72^{de}	4.66^{a}	44.64^{bc}	81.00^{a}	88.00^{a}	34.55^{b}
G-192	92.77^{e}	4.00^{b}	36.58^{d}	74.00^{d}	81.00^{c}	33.77^{b}
G-193	94.19^{de}	4.00^{b}	34.38^{d}	74.66^{cd}	81.00^{c}	31.00^{d}
Benz	98.88^{b}	4.00^{b}	59.68^{a}	75.16^{c}	85.00^{b}	32.22^{c}
TD-1	79.61^{f}	4.33^{ab}	63.66^{a}	65.33^{g}	72.33^{f}	34.11^{b}
Mrc	102.27^{a}	4.66^{a}	59.72^{a}	74.00^{d}	81.00^{c}	39.39^{a}

Means followed by same letters are not significantly different from $p \leq 0.05$

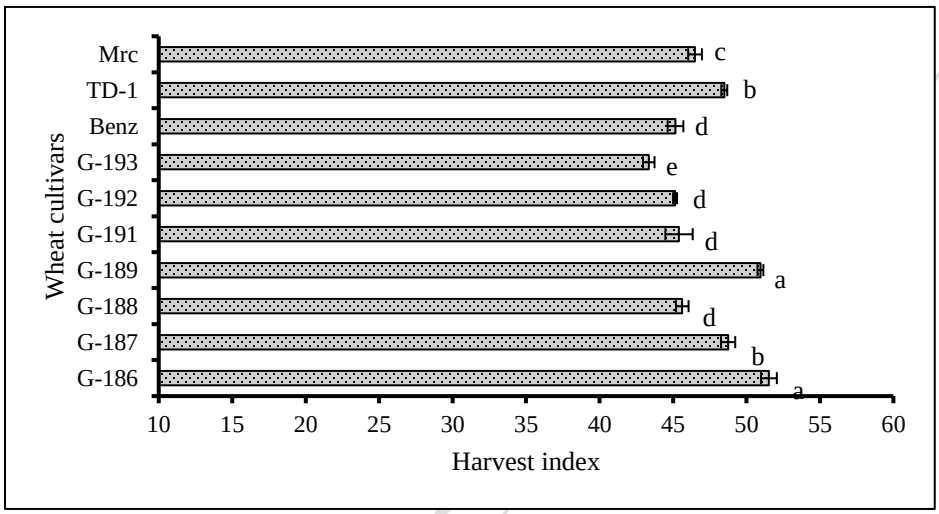

Figure 2. Harvest Index of the tested wheat cultivars

The results of ANOVA revealed a significant differences in terms of yield and yield related attributes among the studied cultivars (Table 2). Cv. TD-1 revealed significantly different and had maximum number of tillers (3.88) followed by cvs. G-193 and G-187. The significantly lower number of tillers with 2.33 was observed for cv. Mrc. The maximum number of spikes per plant was oberved for cv. TD-1 (3.88) followed by G-193 and G-187, whereas the lower number of spikes per plant was observed for cv. Mrc (2.33). The maximum number of spikelets per plant was recorded in cv. G-188 (9.66) which was significantly different among other cultivars except cvs. G-191 and TD-1, whereas the minimum number of spikelets per plant was recorded in cv. Mrc (7.11). The cv. G-186 demonstrated significantly different with maximum spike length (11.66) while significantly lowest spike length was observed for cv. Mrc (6.83). The highest values in terms of ten grain weight was recorded for cvs. G-193 and Benz (3.13 g) which was significantly greater except cv. G-186 (3.09 g), while the lowest values of ten grains weight was recorded for cvs. Mrc (2.77 g) and G-187 (2.80 g). The significantly highest length of ten grains was recorded in cv. G-186 (6.87 cm), while lowest in cv. Mrc (5.52 cm). The cvs. G-186 (44.04 g) and G-193 (42.83 g) appeared significantly highest

in terms of thousand grains when compared to other cultivars, where the cv. Mrc with 34.89 g had lower thousand grains weight followed by G-187 (35.06 g), Benz (36.31 g) and G-192 (36.33 g). The grain yield is a complex polygenetic trait, it depends on the genotype, and is highly susceptible to environmental fluctuations. Its enhancement is usually based on performance of yield components directly associated to the grain yield [9, 20, 21]. Several researches have conducted different studies to evaluate exotic as well as some elite wheat genotypes under agro-ecological conditions of Sindh [22] and Pakistan [23-25] in order to achieve the higher grain yield and quality.

Resistance to rust disease

The area under disease progress curve (AUDPC) is usually expressed in percent days or daily percentage infection values, where higher the values means higher susceptibility of the cultivar [26]. The data presented in (Table 3) regarding disease resistance shows a mixed response. The exotic cvs. G-191 & G-192 and G-186 had higher AUDPC%-days values of 1217.50 AUDPC% days and 1205.0 AUDPC% days respectively than the cv. Mrc (925.0 AUDPC% days) and cv. TD-1 (1130.0 AUDPC% days). In contrast, cv. G-193 resulted with lowest AUDPC%-days (445.83 AUDPC% days) followed by cvs. G-189 (524.17 AUDPC% days), G-187 (610.83 AUDPC% days) and G-188 (675.83 AUDPC% days).

Table 2. Yield and Yield related characteristics of tested exotic wheat cultivars.

Cultivar	Tiller plant^{-1}	Spikes plant^{-1}	Spikelets plant^{-1}	Spike length	Ten grain weight	Ten grains length	Thousand grain weight
G-186	3.11^{e}	3.11^{e}	8.44^{b}	11.66^{a}	3.09^{ab}	6.87^{a}	44.04^{a}
G-187	3.77^{abc}	3.77^{abc}	8.72^{b}	11.05^{b}	2.80^{e}	6.33^{d}	35.06^{d}
G-188	3.50^{cd}	3.50^{cd}	9.66^{a}	10.39^{cd}	3.04^{bc}	6.19^{e}	40.65^{b}
G-189	3.39^{de}	3.39^{de}	8.50^{b}	10.75^{bc}	3.07^{b}	6.19^{e}	37.91^{c}
G-191	3.50^{cd}	3.50^{cd}	9.27^{a}	9.91^{d}	3.00^{cd}	6.13^{ef}	41.13^{b}
G-192	3.55^{bcd}	3.55^{bcd}	8.00^{c}	10.19^{d}	3.05^{bc}	6.45^{c}	36.33^{cd}
G-193	3.83^{ab}	3.83^{ab}	8.83^{b}	11.80^{a}	3.13^{a}	6.83^{b}	42.83^{ab}
Benz	3.55^{bcd}	3.55^{bcd}	8.50^{b}	10.75^{bc}	3.13^{a}	7.10^{a}	36.31^{cd}
TD-1	3.88^{a}	3.88^{a}	9.44^{a}	10.9^{4b}	2.98^{d}	6.06^{f}	41.04^{b}
Mrc	2.33^{f}	2.33^{f}	7.11^{d}	6.83^{e}	2.77^{e}	5.52^{g}	34.89^{d}

Means followed by same letters are not significantly different from $p \leq 0.05$

Table 3. Mean AUDPC values for the tested wheat cultivars.

Cultivar	n	AUDPC (%-days)	Relative AUDPC (no units)	r (logit day^{-1})
G-186	3	1205.00	13.85	-0.09
G-187	3	610.83	7.02	-0.24
G-188	3	675.83	7.77	0.17
G-189	3	524.17	6.02	-0.15
G-191	3	1217.50	13.99	-0.09
G-192	3	1217.50	13.99	-0.09
G-193	3	445.83	5.12	-0.11
Benz	3	1352.50	15.55	-0.08
TD-1	3	1130.00	12.99	-0.09
Mrc	3	925.00	10.63	0.00

Lower AUDPCs represent slower disease progression and greater resistance to the disease. Higher AUDPCs represent faster disease progression and higher susceptibility to the disease. *r*-Value, rate of leaf rust

Conclusion

Seven bread wheat genotypes, two local and one check variety cultivars were evaluated for variability of number of morphological and yield associated traits, and resistance to leaf rust disease. The exotic cvs. G-186 and G-189 resulted with highest harvest index as compared to other cultivars. The cvs. G-193 and G-186 resulted with higher thousand grain weight. The cv. G-193 resulted with lowest AUDPC%-days values, representing its higher resistance to the deadly wheat rust disease and recommended further to cultivate on large scale. The information on diversity among the agro-morphological traits of the wheat genotypes will be helpful to plant breeders in constructing their breeding materials and implementing selection strategies.

Author's contributions

Conceived and designed the experiments: LB Bhanbhro & HB Bozdar, Performed the experiments: LB Bhanbhro, AA Bughio & M Faheem, Analyzed the data: LB Bhanbhro, MA Jatoi & M Arshad, Contributed reagents/ materials/ analysis tools: LB Bhanbhro, SA Soomro, AA Rajper & AA Mirani, Wrote the paper: LB Bhanbhro & SA Soomro.

References

1. Zhao FJ, Su YH, Dunham SJ, Rakszegi M, Bedo Z, McGrath SP & Shewry PR (2009). Variation in mineral micronutrient concentrations in grain of wheat lines of diverse origin. *J Cereal Sci* 49(2): 290-295**.**
2. Raza A, Razzaq A, Mehmood SS, Zou X, Zhang X, Lv Y & Xu J (2019). Impact of Climate Change on Crops Adaptation and Strategies to Tackle Its Outcome : A Review. *Plants* 8(2): 8020034.
3. Baloch A, Baloch M, Baloch M, Kandhro R, Kandhro M, Gandahi N, Baloch G, Baloch I, Ali M & Baloch A (2016). Evaluation of exotic bread wheat genotypes for yield and its associated traits. *Int J Biol Biotechnol* 13: 107-110.
4. Jamali LA, Soomro SA, Abro AA, Khan ZA & Walhari NH (2016). Effect of grain moisture content on physico-engineering properties of wheat. *J Agric Res* 54(4): 773-785**.**
5. Savary S, Ficke A, Aubertot JN & Hollier C (2012). Crop losses due to diseases and their implications for global food production losses and food security. *Food Secur* 519-537.
6. Line RF (2002). Stripe rust of wheat and barley in North America: a retrospective historical review. *Annu Rev Phytopathol* 40(1): 75-118.
7. Kahrizi D, Cheghamirza K, Kakaei M, Mohammadi R & Ebadi A (2010). Heritability and genetic gain of some morphophysiological variables of durum wheat (*Triticum turgidum* var. durum). *African J Biotechnol* 9(30): 4687-4691.
8. Asseng S, Ewert F, Martre P, Rötter, Lobell D, Cammarano D, Kimball B, Ottman, M, Wall, G & White JW (2015). Rising temperatures reduce global wheat production. *Nat Clim Change* 5: 143-147.
9. Ashfaq M, Khan AS & Ali ZU (2003). Association of morphological traits with grain yield in wheat (*Triticum aestivum* L.). *Int J Agric Biol* 5(3): 262-264.
10. Saleem U, Khaliq I, Mahmood KT & Rafique M (2006). Phenotypic and genotypic correlation coefficients between yield and yield components in wheat. *J Agric Res* 44(1): 1-6.
11. Lopes MS, El-Basyoni I, Baenziger PS, Singh S, Royo C, Ozbek K, Aktas H, Ozer E, Ozdemir F, Manickavelu A & Ban T (2015). Exploiting genetic diversity from landraces in wheat breeding for adaptation to climate change. *J Exp Bot* 66(12): 3477-3486.
12. Aggarwal P (1993). Agro-ecological zoning using crop growth simulation models: characterization of wheat

environments of India. *Syst approaches Agric Dev* 2: 97-109.
13. Donmez E, Sears RG, Shroyer JP & Paulsen GM (2001). Genetic gain in yield attributes of winter wheat in the Great Plains. *Crop Sci* 41(5): 1412-1419.
14. Soomro A, Nauman M, Soomro SA, Tagar AA, Soomro SA, Buriro M, Gandahi AW & Memon AH (2017). Evaluation of raised-bed and conventional irrigation systems for yield and water productivity of wheat crop. *J Basic Appl Sci* 13: 143-149.
15. Soomro SA, Thebo SA & Chen K (2018). Physico-engineering properties of different rice varieties grown in Sindh province of Pakistan. *Int Agric Eng J* 27(1): 275-280**.**
16. Peterson RF, Campbell AB & Hannah AE (1948). A diagrammatic scale for estimating rust intensity on leaves and stems of cereals. *Can J Res* 26(5): 496-500.
17. Arain S, Sial M, Leghari K & Jamali K (2017). Comparative performance of promising advanced Wheat Genotypes with commercial Wheat cultivars in Sindh. *Pakistan J Biotechnol* 14: 163-166.
18. Destro D, Miglioranza E, Arias CAA, Vendrame JM & Almeida JCV (2001). Main stem and tiller contribution to wheat cultivars yield under different irrigation regimes. *Brazilian Arch Biol Technol* 44(4): 325-330.
19. Khan A, Salim I & Ali Z (2003). Heritability of Various Morphological Traits in Wheat. *Int J Agric Biol* 5: 138-140.
20. Yan W & Hunt L (2001). Interpretation of genotype × environment interaction for winter wheat yield in Ontario. *Crop Sci* 41(1): 19-25.
21. Razzaq A, Ali Q, Qayyum A, Mahmood I, Ahmad M & Rasheed M (2013). Physiological responses and drought resistance index of nine wheat (*Triticum aestivum* L.) cultivars under different moisture conditions. *Pak J Bot* 45(1): 151-155.
22. Ghanghro A, Qureshi R, Balouch A, Javed M & Sohu M (2001). Yield Potential of Exotic Wheat Genotypes under Tando Jam Conditions. *Pakistan J Bot* 33: 637-640.
23. Shah S, Sahito M, Tunio S & Pirzado A (2009). Genotype-environment interactions and stability analysis of yield and yield attributes of ten contemporary wheat varieties of Pakistan. *Sindh Univ Res J* 41: 13-24.
24. Longove M, Akbar F, Baqa S, Hidayatullah & Azam S (2014). Performance Evaluation of Different Wheat Varieties under Agro-Ecological Conditions of Quetta (Balochistan). *J Biol Agric Healthc* 4: 39-43.
25. Baloch M, Hussain I, Aziz A, Naveed K, Amjad M, Hashim M & Hussain N (2015). Growth and yield of wheat varieties under the agro-ecology of dera ismail khan. *Gomal Univ J Res* 31: 18-28.
26. Jeger MJ & Viljanen-Rollinson SLH (2001). The use of the area under the disease-progress curve (AUDPC) to assess quantitative disease resistance in crop cultivars. *Theor Appl Genet* 102(1): 32-40.