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EVALUATION OF GROWTH AND YIELD ATTRIBUTES OF SOME WHEAT VARIETIES UNDER LOCAL CONDITIONS OF SOUTHERN PUNJAB, PAKISTAN

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ABSTRACT

Understanding how changing environment and cultivars influence crop phenology and potential yield is essential for crop adaptation to future climate change. Plant Genetic Diversity (PGD) provides the basis for survival in plants in nature and for crop improvement. Under changing climate scenario and increase in population pressure, wheat genotypes with attributes such as; short duration, lesser water loving, and abundant yield potential are of considerable importance. The present study was designed to evaluate best wheat genotypes which may better perform under the changing climatic conditions of southern Punjab, Pakistan. A field trial to study the comparative performance of newly evolved four genotypes; Millat-2011, Faisalabad-2008, Punjab-2011 and AARI-2011 was conducted at two different agro-climatic conditions of Dera Ghazi Khan, Punjab, during crop season, 2013-2014. The design used was randomized complete block with three replicates. Plot size was maintained as (4 x 6m) and (2.5x 6m) respectively, for site-1 & 2. Seed rate of 125 kg ha^{-1} was used. The recommended dose of NPK (128-114-62 Kg/ha), irrigation, weed control methodology and all other agronomic practice were kept the same for all the treatments in both sites. Statistical analysis of the data was carried out by studying different yield components (Germination count m^{-2}, Number of Fertile tillers m^{-2}, No. of spikelets spike^{-1}, Plant height at maturity, Spike Length, No. of grains spike^{-1}, 1000 grain weight and Grains yield) and their means were separated by using the least significance difference test. As per results achieved from the experiment, performance (growth and yield attributes) of genotype Millat-2011 was best as compared to all other genotypes tested under local condition. Millat-2011 recorded a significant increase in all growth and yield variables, including germination, grains number, test weight and yield of wheat under local conditions as compared to rest three genotypes.

Keywords: Wheat genotypes, Agro-climate, Genetic variation and Yield components.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop that occupies the central position of the world agriculture. Wheat is the main staple food of the people of Pakistan and the largest grain crop of the country. It contributes 25.6% to the value added agriculture and 5.4% to GDP. It is grown on an area of about 9.03 million hectares with a total grain production of 25.2 million tones and an average yield of 2.7 thousand kg ha^{-1} (Govt. of Pakistan, 2015).

Wheat is nutritious food rich in proteins, minerals, vitamins and dietary fiber (Afzal *et al.*, 2013; Kumar *et al.*, 2011).

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Mwadzingeni *et al.* (2016) found that by adding characters like drought tolerance in wheat would be a great revolution to feed increasing mouths. It is being used as staple food in Pakistan and fulfils the 60% of total calories and protein needed for the daily life and about 65% of the wheat grain is used by humans worldwide (Khan *et al.*, 2009).

Despite extensive research work over the last few decades, the country has yet to achieve the goal of self-sufficiency. Further, the rapid increase in population also demands an increase in food production. Development of new varieties with desirable yield and associated traits offers the best solution to the problems of low productivity. Genetic variability exists for various yield and yield related traits in wheat (Ali *et al.*, 2007). Each variety has a genotype-specific ability to maintain performance over a wide range of environmental conditions. This ability is usually referred to as the sensitivity or adaptability of a variety (Longove *et al.*, 2014). Also, there exists a relationship between various yield related traits with grain yield (Zulfiqar and Ashfaq, 2014). According to Ayaz (2016), there is a direct relationship between biological yield and 100 grain weight and also between 100 grains weight with grains yield among various wheat cultivars.

The cultivars developed and adapted in a particular agro-ecological zone usually remain sufficiently stable for the expression of morpho-physiological characters but occasionally behave differently when exposed to other zones with different growing conditions. Changing crop phenology is considered an important bio-indicator of climate change, with the recent warming trend causing an advancement in crop phenology. the effects of climate change on crop phenology have interacted with the effects of changes in crop management, such as modified sowing dates and changing cultivars (Liu *et al.*, 2009).

Wheat research in Pakistan has been a success story. Developing varieties in demand with the local and zonal requirements and strategic planning to deploy matching production technology have contributed a lot in this endeavour. To strengthen the role of wheat in food security under changing climatic conditions, it is pertinent to develop wheat varieties and check their adaptation in various agro-climatic conditions. Mohan (2014) observed that locations alter not only the yielding ability of a genotype but also the yielding potential of sites located in the specific region.

Despite to higher yield potential, average yield, of different cultivars, in Pakistan is much less than the most countries of the world. To meet the increasing demand of food grains for rapidly growing population of the country, it is need of time to identify such high yielding wheat varieties which may contribute higher yield per unit area and specific for a particular region. So in addition to a number of factors influencing yield attributes, the vital factor for harvesting suitable environment into grain yield is the genetic potential of the crops (Nadeem, 2001).

The objective of this research was to find out genetic variation for different yield traits among the locally adapted wheat varieties sown under varying locations in Southern Punjab, Pakistan to quantify the contributions of changes in cultivars and locations to the changes in the phenology of wheat. In this way cultivar with best display and performance in a proper location can be recommended to farming community.

MATERIALS AND METHODS

The research study was carried out at two different sites, Site I: At farmer field (Abdul Rashid Sial, Mauza Kotla Shafi, Dera Ghazi Khan) It is located at laltitude 29.044731 and longitude 69.627763 and Site II: (Agricultural Adaptive Research Farm Dera Ghazi Khan located at laltitude 31.046639 and longitude 71.687113) during 2013-14. Four new wheat varieties included in this study were Millat-2011, Faisalabad-2008, Punjab-2011 and AARI-2011. A randomized complete block design was used with three replications. Each variety was planted in four rows per plot. Recommended seed rate 125 kg ha^{-1} was sown with the drill in plot size (4x 6m) and (2.5x 6m) respectively, for site-1 & II. Recommended doses of nitrogenous, phosphorus and potassium (128-114-62 Kg ha^{-1}) fertilizers were applied in the form of Urea, Triple Super Phosphate and Sulphate of Potash. Nitrogen fertilizer was applied in three splits; one-third Nitrogen & whole of Potassium & phosphorus were applied at the time of seedbed preparation and was thoroughly mixed into soil by ploughing and planking. The 2nd (1/3) of Nitrogen was applied at the time of 1st irrigation & 1/3rd at the time of 3rd irrigation. The canal water was used for irrigation. Standard agronomic practices were carried out during the growing season.

Data on germination count (m^{-2}) was recorded by counting the number of germinated plants m^{-2} from each plot of both sites. Numbers of productive tillers (m^{-2}), Spike Length and plant height (cm) were counted at maturity. Number of grains spike^{-1}, Number of spikelets spike^{-1}, 1000 grain weight (g) and grain yield (kg ha^{-1}) were counted by selecting ten spikes randomly in each subplot from both sites. Firstly, number of spikelets spike^{-1} were counted and then number of grains for each spike after threshing. Average data was calculated for these parameters.

Thousand grains were collected from threshed clean grains of each plot and weighed with the help of sensitive electronic balance to calculate thousand grains weight (g). Grain yield per plot was determined by threshing the material harvested for grain yield. Data generated were statistically analyzed using analysis of variance techniques appropriate to simple RCB Design upon obtaining significant differences, least significant difference (LSD) test was used for comparison among the treatment means (Jan *et al.*, 2009).

PHYSIO-CHEMICAL SOIL CHARACTERISTICS Soil analysis report pertaining to Physio-Chemical soil characteristics for both sites was obtained from Soil and Water testing Laboratory at Dera Ghazi Khan, Punjab, Pakistan by providing the composite soil samples of each experiment site.

(i) Physio-chemical characteristics	(ii): Physio-chemical characteristics of soil at SITE-I of soil at SITE-II.
Electrical conductivity 3.20 m cm-1	Electrical conductivity 3.04 m cm-1
Soil pH 7.80	Soil pH 8.40
Organic matter0.48 %	Organic matter0.20 %
Available phosphorous6.00 ppm	Available phosphorous4.00 ppm
Available potassium205.00 ppm	Available potassium98.00 ppm
Saturation 66%	Saturation 50%
Texture Loam	Texture Loam

Table 1. Meteorological data recorded during the crop growth period 2013-14.

Months	Max. Temp. (°C)	Min Temp (°C)	Relative Humidity (%)	Rainfall (mm)
November 2013	26	15	88	1.0
December 2013	18	09	78	5.0
January 2014	16	06	86	6.5
February 2014	22	08	78	2.0
March 2014	28	16	88	20.0
April 2014	33	22	78	0.5
May 2014	42	25	68	00

RESULTS AND DISCUSSION

Germination Count m^{-2}: Varieties showed statistically significant differences (P<0.05) for germination count m^{-2} (Table-2). Mean data showed plant germination ranged from 173.00 to 187.67 from site-1 and from 202.00 to 210 from site-2. According to data received, AARI-2011 exhibited minimum (173 & 202) germination count m^{-2} while, Millat-2011 gave maximum (187.67 & 210.11) number of plants m^{-2} from site-1 & 2, respectively (Table-2). Faisalabad-2008 remained intermediate at both the sites regarding germination count. Variation in germination count m^{-2} for all 4 cultivars at both the sites depicted that different cultivars had different inner seed reserves which are displayed in various agro-climatic conditions in accordance with their genetic makeup by utilizing available soil reserves/nutrients at both sites.

These observations are in conformity to the findings of Naveed *et al.* (2014) and Mushtaq *et al.* (2011) who were of the view that various wheat varieties depict varying germination count which is their inherent character in addition to soil and climatic influences. Similarly, Nadeem (2001) also found similar results and found significant differences for germination count among the different wheat varieties.

Number of fertile tillers m^{-2}: Final grain yield of wheat is mainly a function of the number of spikes bearing tillers (fertile tillers) per unit area at harvest. Productive tillers per unit area (m^{-2}) significantly varied (P<0.05) among various cultivars (Table 2). The highest number of productive tillers of 282 &285 m^{-2} were observed in Millat-2011 from both sites respectively, which differed significantly from Faisalabad-2008 (272 & 284) at both the sites respectively, Punjab-2011 (265.33 & 281) and AARI-2011 (256.67 & 280.67) from site 1&2, respectively, thus AARI-2011 produced minimum number of tillers m^{-2}. Statistical variation was seen among all genotypes at site-I as compared to site-II where number of tillers m^{-2} in Punjab 2011 were statistically at par to the number of tillers m^{-2} produced by genotype AARI-2011. Our results are in close conformity with those of Naveed *et al.* (2014) and Musaddique *et al.* (2000) for various genotypes who found variation in tillers count due to effect of variables like available soil nutrients at experimental site, prevailing climatic conditions during crop life cycle and genetic inheritance of cultivar. Similar trends were observed by Irfaq *et al.* (2005) who stated that different varieties respond differently due to difference in their genetic makeup, as far as the difference at different location was justified with change in agro-physiological and ecological conditions.

Table 2. Evaluation of different wheat varieties and their comparative performance under local conditions of D.G. Khan, Punjab, Pakistan.

Varieties	Growth and Yield parameters							
	Germination m^{-2}		Productive tillers m^{-2}		Plant Height (cm)		Spike Length (cm)	
	Site-I	Site-II	Site-I	Site-II	Site-I	Site-II	Site-I	Site-II
Millat-2011	187.67 a	210.11 a	282.00 a	285.00 a	91.10 b	93.00 b	12.30 a	12.00 a
Faisalabad-2008	181.67 b	204.33 b	272.00 b	283.00 b	97.50 a	96.11 a	11.56 a	12.10 a
Punjab-2011	178.00 b	203.51 b	265.33 c	281.00 c	92.20 b	90.10 b	11.06 ab	10.56 b
AARI-2011	173.00 c	202.00 b	256.67 d	280.67 c	88.09 c	84.90 c	10.10 b	10.22 b
LSD Value $_{(0.05\%)}$	3.84	5.65	6.14	1.73	2.349	2,288	0.774	0.720

Varieties	Growth and Yield parameters							
	No. of Spikelets spike^{-1}		No. of Grains Spike^{-1}		1000 Grain wt. (g)		Grain yield (Kg Ha^{-1})	
	Site-I	Site-II	Site-I	Site-II	Site-I	Site-II	Site-I	Site-II
Millat-2011	18.20 a	16.24 a	39.69 a	42.25 a	42.12 a	36.28 a	4212.10 a	4165.50 a
Faisalabad-2008	16.01 b	15.78 a	37.85 b	39.45 b	39.76 bc	35.44 b	4127.10 a	3993.90 ab
Punjab-2011	16.12 b	15.50 b	37.69 b	39.13 b	40.03 b	35.30 b	3970.70 b	3840.70 bc
AARI-2011	14.56 c	13.10 c	36.94 b	38.52 b	38.14 c	33.36 c	3907.00 b	3738.00 c
LSD Value $_{(0.05\%)}$	0.863	0.812	1.79	1.33	1.87	0.19	119.97	192.31

Plant height at maturity (cm): Plant height at maturity is a function of combined effects of genetic make-up. Data regarding plant height at maturity showed significant differences among the different genotypes are given in Table-2. Comparative study of the means for different genotypes showed that maximum plant height (97.50 cm) was achieved in Faisalabad-08 as compared to AARI-11 variety where the least plant height (88.09 cm) was recorded. The same type of trend was also recorded at Site-II. Similar results were obtained during experimentation by Naveed *et al.* (2014) and Musaddique *et al.* (2000) for various genotypes during which they found that each variety has its own feature from the growth viewpoint and variation in plant height was recorded as their genetic character. Our results are in accordance with the findings of Shuaib (2010) who reported that Plant height is considered as a genetic character of a plant which is modified by the environmental conditions under which it is grown. Temperature and intercepted solar radiation may influence the plant height to certain degree by drawing the conclusion that plant height is a genetic character, but environmental conditions modify this genetic potential.

Spike Length (cm): The data relating to spike length as influenced by different genotypes is presented in Table 2. Data regarding spike length at maturity showed significant differences among the different genotypes. The cv. Millat-11 showed a significant increase of 23.10% in the spike length as compared to cv. AARI-2011 by giving 12.30 cm length which was statistically at par with cv. Faisalabad-08 and Punjab-11. Similarly at a second location, about the same trend was noted but here,Cv Faisalabad-08 produced higher spike length of 12.10 cm while, cv.AARI-11 gave spike of lesser length (10.22 cm).This variation in spike length is due to genetic variability among different genotypes thus producing spikes of different length which is in close conformity with the results of Naveed *et al.* (2014) and Mushtaq *et al.* (2011) those found many variations in spike length along with other growth parameters in wheat crop. Nadeem (2001) and Shuaib (2010) were of the view that spike length variation among different cultivars is due to variation of available soil nutrients and prevailing environments at particular site in combination with genetic inheritance of that cultivar. Thus, favorable growing period and nutrients availability are dominantly expressed in terms of long spike length by best cultivar.

Number of Spikelets Spike^{-1}: The data relating to number of spikelets spike^{-1}as influenced by different genotypes is presented in Table 2. Data regarding the number of spikelets spike^{-1} at maturity showed statistically significant differences among the different genotypes. The cv. Millat-11 showed a significant increase of 25.00% in the number of spikelets spike^{-1} as compared to cv. AARI-2011 by giving 18.20 count as against minimum count of 14.56 in case of cv. AARI-11. Similarly, at the second location, about the same trend was noted. Cv. Millat-11 and Faisalabad-08 produced the highest count as against minimum count in cv. AARI-11. A number of spikelets per spike and grains per spike are generally the most important determinants of grain yield indicating genetic diversity and net assimilate accumulation. These results are line with the findings of Mushtaq *et al.* (2011), Kiliç and Gürsoy (2010) and Naveed *et al.* (2014) who found variation in yield attributes for different cultivars explaining their genetic behaviour. Similarly, Ayaz (2016)Ayaz (2016) is of the view that spikelets spike^{-1}, number of grains per spike and spike length are correlated with biomass and leaf area of the crop which are different for various cultivars.

Number of grains spike^{-1}: Data given in Table-2 showed that there were significant ($p<0.05$) variations in different wheat genotypes on the basis of number of grains spike^{-1}. Maximum number of grains spike^{-1} (39.69 & 42.25) was recorded in Millat-2011 followed by Faisalabad-2008 (37.85 &39.45), Punjab-2011 (37.69 & 39.13) and AARI-2011 (36.94 & 38.52) producing minimum number grains spike^{-1} from site-1 & 2, respectively. Many factors are responsible to effect grains spike^{-1} such as genotype, cultural practices used like seeding rates, planting dates and soil fertility etc and growing conditions like air and soil temperature, soil water status and nutritional status in addition to weather change, can impact this character. Spike per unit area and kernel per spike are generally the most important determinants of grain yield. These results are line with the findings of Kiliç and Gürsoy (2010) and Naveed *et al.* (2014) who found variation in yield attributes for different cultivars explaining their genetic behaviour. Similarly, Ayaz (2016) is of the view that a number of grains per spike is correlated with biomass and leaf area of crop, as more assimilation and photosynthate translocation is possible in varieties with higher biomass, thus giving higher grains count per spike. As cultivars were grown at 2 different sites so all 4 cultivars showed variation in grains count per spike due to nutrients availability at that site, prevailing growing condition and varietal genetic makeup.

1000-grains weight: Statistically significant differences in 1000-grain weight were found among different cultivars of wheat (Table 2). The maximum 1000 grain weight varied from 42.12 & 36.28 g, produced from Millat-2011 and minimum grain weight of 38.14 &33.36 g was achieved from AARI-2011. Overall, as per varietal behaviour here again AARI-2011 gave lesser grain weight as discussed earlier which depicts its poor performance regarding yield attributes. These results are similar with the findings of Arif *et al.* (2006) and Kiliç and Gürsoy (2010). They reported differences in 1000 grains weight for different cultivars. Similarly, Naveed *et al.* (2014) and Shuaib (2010) reported the same findings for 1000 grains weight among various genotypes. Irfaq *et al.* (2005) also described significant differences for 1000- grain weight among wheat varieties at different locations because of the difference in number of grains spike^{-1} and number of tillers m^{-2} among different varieties which might be due to soil type and environmental conditions like temperature, humidity and rainfall as shown in Table 1 in addition to varietal genetic makeup.

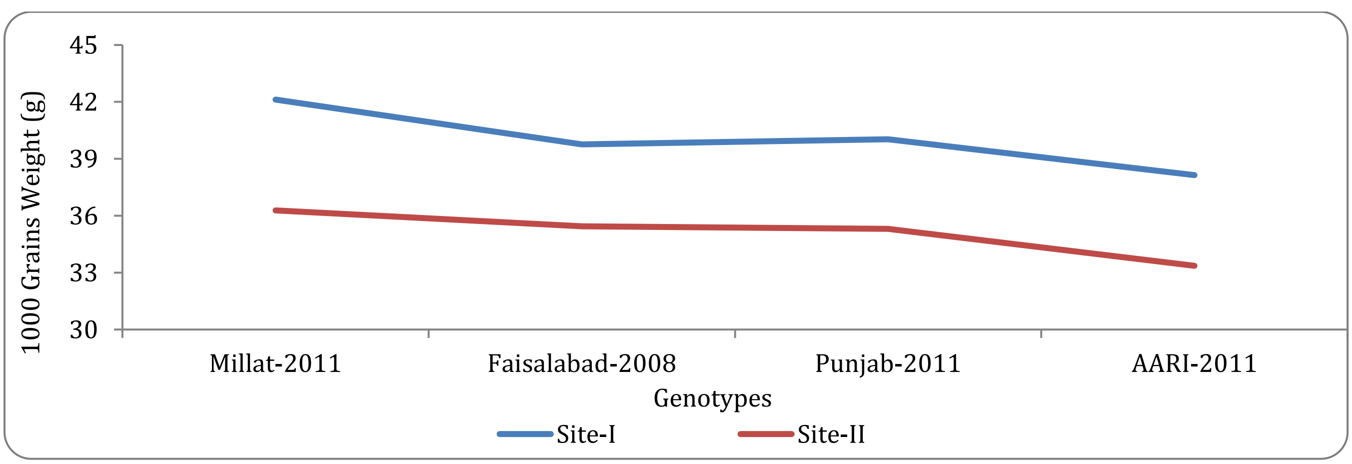

Figure 1. Correlation of 1000 grains weight (g) with different genotypes sown in varying environments.

Grain Yield (Kg Ha^{-1}): According to data received statistically significant differences (P<0.05) among various wheat genotypes for grain yield were observed (TableI-2). Highest grains yield from both sites ranged between 4212.10 & 4165.50 **(**Kg Ha^{-1}**)** for Millat-2011 and minimum yield of 39.07 & 3738 kg ha^{-1} in AARI-2011, respectively. The difference in yield of all the varieties is due to the genetics of varieties to show their potential under these conditions. The above results are in confirmation with the findings of Bilalis *et al.* (2011), Bazzaz *et al.* (2015) and Naveed *et al.* (2014).

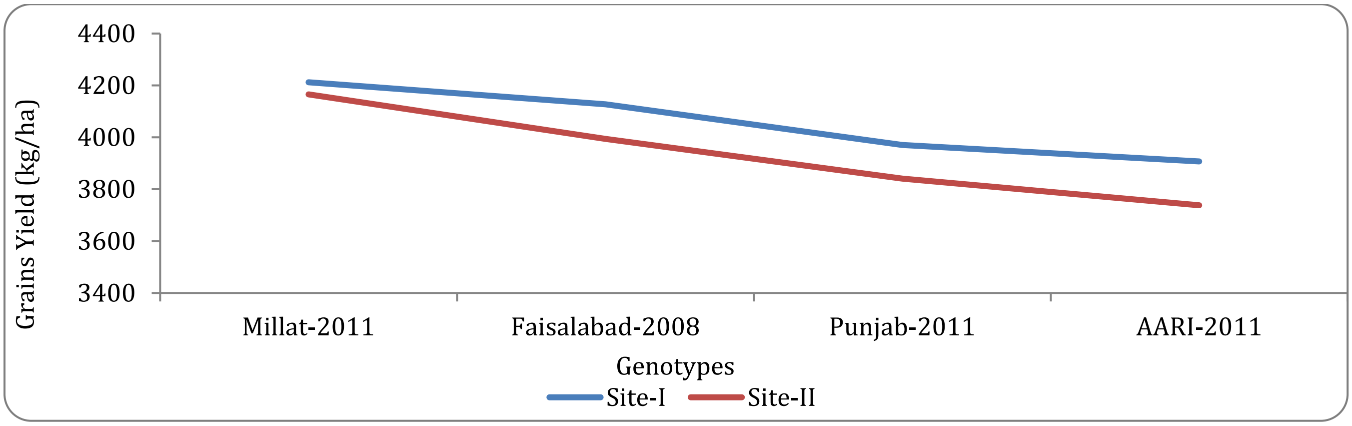

Figure 2. Correlation of grains yield (kg ha^{-1}) with different genotypes sown in varying environments.

Grain yield of the wheat crop is the function of its individual yield components in response to the genetic potential of varieties, environmental conditions and input used. The increase in grains yield is due to the higher assimilates translocation to the reproductive organs which is considered the genetics of cultivar. The genetic performance of variety leads to more seed set, a number of seeds spike^{-1}, 1000 grain weight and finally, the maximum grain yield. Ali and Inamullah (2014), Shuaib (2010) and Malik *et al.* (2009) also reported the improvement in a number of spikelets per spike, grain number per spike and ultimately higher grains yield of the wheat crop due to the result of best cultivar performance in favorable soil and climatic conditions.

The differences in Grains yield at different locations might be due to soil type, environmental conditions like temperature, humidity and rainfall as shown in Table 1. Nadeem (2001) also showed his results in conformity with this study and found significant differences among the different wheat varieties.

CONCLUSION

Growth and yield performance of genotype Millat-2011was more as compared to all other genotypes followed by Faisalabad-2008 tested under local climatic and soil conditions of Southern Punjab. Significant increase in all growth and yield variables including Germination count m^{-2}, Number of Fertile tillers m^{-2}, No. of spikelets spike^{-1}, Plant height at maturity, Spike Length, No. of grains spike^{-1}, 1000 grain weight and Grains yield, was observed maximum in favor of Millat 2011 following Faisalabad-2008 while, AARI 2011 showed the poor performance in all these attributes under local conditions. The major mechanism responsible was the genetic performance of Millat-2011 which enabled this cultivar to increase the uptake of nutrients thus enhancing its growth and yield performance. It is therefore recommended that for getting maximum productivity of wheat, sowing of Millat 2011 should be promoted under local conditions of Southern Punjab. Further research is required to explore the genetic performance and adaptability of newly evolved varieties for better recommendations in Southern Punjab, Pakistan.

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