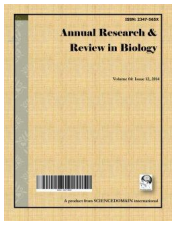

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Morpho-Physiological Analyses of Selected Wheat Genotypes

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Authors' contributions

This work was carried out in collaboration between all authors. Author IUR performed the experiments and interpreted the data, authors AHS and IN designed the study and helped in data interpretation, authors SQA and HA provided the research facilities and helped data analyses. All authors read and approved the final manuscript.

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ABSTRACT

Present research evaluated seventeen genotypes of wheat along with three check varieties (PS-05, Siran and Atta-Habib) under the field conditions of Agriculture Research Station (ARS) Baffa, Mansehra to identify the most suitable and high yielding variety based on morpho-physiological/agronomic traits. The experiment was carried out during 2013-14 in Randomized Complete Block Design (RCBD) with three replications. Data showed significant differences for almost all of the traits. Maximum spike length (14.5 cm, 14 cm, and 13.8 cm), number of grains per spike (95, 94 and 87) and grain yield (5825 kg ha^{-1}, 5666 kg ha^{-1} and 5567 kg ha^{-1}) were recorded for genotypes 105, 108, 110 respectively. While maximum 1000 grain weight (60 gm, 50 gm and 48 gm), was recorded for genotypes 132, 105, 108 and 110 correspondingly. Similarly maximum number of tillers (13.5) and plant height (101.6) were recorded for genotypes 118 and 132 individually. On the other hand minimum days to germination (9), plant height (65.5), spike length

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(9.2), number of grain per spike (68.5), 1000 grain weight (40) and grain yield (2667 kg ha^{-1}) were observed in the genotypes A-Habib, 105, 117, 132, 101 and 126 respectively. Correlation analyses revealed that spike length, number of grains per spike and grain yield per hectare was positively and significantly correlated with each other. While significantly negative correlation was observed for plant height with spike length, number of grains per spike and grain yield per hectare. Due to high yielding ability the genotypes 105, 108 and 110 are recommended for general cultivation in Mansehra and similar climatic regions.

Keywords: Wheat; genotypes; tillers; yield; spike; grains.

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most vital cereal of the world that belongs to monocot family poaceae [1]. Wheat is a cereal grass that belongs to genus Triticum. It has been described as the 'King of Cereals' because of the land it occupies, maximum production and the important place it holds in the International food grain trade. Majority of the cultivated varieties of wheat belongs to three major species of the genus *Triticum* such as diploids (*Triticum monococcum*) having 14 (n=7), tetraploids (*Triticum durum*) having 28 (n=14) and the hexaploids (*Triticum aestivum*) having 42 (n=21) chromosomes [2]. Wheat is a essential cereal crop from all views. It provides 72% of extra calories and proteins in diet. The ripened grain (fruit) of wheat contains approximately 80 to 84% endosperm 60% carbohydrate (starch), 10 to 16% protein, 2% fat and approximately 13% water [3].

World wheat production during 2009-10 decreased to 0.32% as compared to previous cropping season (2008-09). This decrease in wheat production might be due to several reasons such as improper agronomic practices, poor management and unfavorable weather conditions such as high temperature, drought and salinity [4,5].

Wheat is one of the major staple food crops of Pakistan. Total area under wheat cultivation in Pakistan is 9.042 million hectares with annual production of 23.86 million tones with an average yield of about 2639 kg ha^{-1} [4]. Despite higher yield potential, average grain yield of wheat in Pakistan is much less than most of the countries of the world including China, India, USA, Russia and France. The factors which cause reduction in the yield of wheat in Pakistan are low quality seed, salinity, water logging, inadequate use of fertilizers, lack of irrigation water, high input prices, low farmers education, no use of micronutrients organic fertilizers and improper cultivation of wheat varieties under different Agro climatic conditions of the region [6].

Maximum yielding wheat variety is a major aim of wheat breeding programs all over the world. To increase the yield production of wheat, there are two ways i.e. either to increase the cultivation area or by increase its yield per unit area. It is difficult to increase area of cultivation due to other competitive rabi crops. The only possible solution is to get higher yield per unit area by the production of new high yielding varieties and better crop management [7]. While morphological/physiological characterization is the first step, based on multiple traits that can be used to select the genotypes/varieties with desired agronomic traits for breeding to get maximum yield [8]. Therefore a systematic investigation was made to study the morphological and agronomic characterization of wheat germplasm under agro climatic conditions of Mansehra to i. evaluate different wheat germplasm for physiological and morphological characters, ii. identify the reliable and distinguishing characters among advance breeding lines of wheat which could be linked with wheat quality.

2. MATERIALS AND METHODS

The present research work was conducted at Agriculture Research Station Baffa Mansehra during 2011-2012. District Mansehra is located at the eastern border of the Khyber Pukhtunkhwa, 244 km away from Peshawar and 170 km away from Islamabad. The district is geographically located at latitude (34.34 degrees) 34° 20' 24" North of the Equator and longitude (73.2 degrees) 73 12' 0" East of the Prime Meridian on the Map of the world. The climate is warm and temperate in Mansehra. The rainfall in Mansehra is significant, with precipitation even during the driest month. In a year, the average rainfall is 1445 mm. The experimental material consisted of 17 genotypes (101, 105, 107, 108, 109, 110, 112, 113, 115, 117, 118, 119, 120, 122, 123, 126

and 132) and three commercial varieties (Pirsabak 2005, Siran and Atta Habib) were used as check. The experimental design was Randomized Complete Block Design (RCBD) with three replications. Each replication consisted of 20 plots and each plot consisted of four rows, each row was five meter long and 30cm apart from each other. The plot size was 5 m × 1.2 m = 6 m^2. The total experimental area was 6 m^2 × 60 = 360 m^2. The field was prepared thoroughly, using standard cultural practices. Split doses of fertilizers, Urea and DAP was applied. One dose of fertilizers (NPK 140-60-50) was applied at sowing time and the other dose of fertilizers (NPK 140-60-50) was applied after 25 days of sowing. Herbicides like Affinity Bacteria IM and Topic were applied in order to control Weeds. Harvesting was carried at Physiological maturity, when the colors of the spike were changed from green to pale yellow. Data was collected by random selection of five plants within each plot. The average data of five randomly selected plants were considered as the actual data for each parameter.

2.1 Statistical Analyses

The data calculated were then compiled and for further statistical analysis statistical software MSTATC (MSTATC, VERSION 2) was used. Using this software Analysis of variance (ANOVA) and Least Significance Difference (LSD) were applied.

3. RESULTS

3.1 Days to 50% Germination

Days to germination were counted from the date of sowing to the seedling. The analysis of variance (ANOVA) showed that all the genotypes for days to germination were non-significant indicating that germination time for all the genotypes were the same (Table 1). Among all the genotypes, eleven genotypes (101, 107, 109, PS-05, 110,112,113,115,119,123 and 126) recorded 9.5 days to germination. Eight genotypes (105, 108, 117, Siran, 118, 120, 122 and 132) recorded 10 days to germination. Whereas genotype A-Habib recorded 9 days to germination.

3.2 Plant Height (cm)

Plant height of wheat genotypes showed significant differences with observed means ranging from 65.5 to 102.8 cm. Maximum plant height of 102.8 cm was recorded in genotype Siran followed by genotype 132 with plant height of 101.6 cm. Minimum plant height (65 cm) was recorded for the genotype 105. Other genotypes showed the plant height as 101 (94.2 cm), 107 (94.5 cm), 108 (70.3 cm), 109 (99 cm), PS-05 (97.6 cm), 110 (74.1 cm), 112 (70.8 cm), 113 (100.7 cm), 115 (77 cm), 117 (98.1), 118 (80.1 cm), 119 (90.1 cm), 120 (80.7 cm), 122 (99.4 cm), 123 (100.1 cm) 126 (95.8 cm), and A-Habib (91.5 cm). The LSD value for Plant height was 1.890 at α (alpha) level 0.05 as shown in Table 1.

3.3 Number of Tillers per Plant

The result obtained from the analysis of variance showed that numbers of tillers per plant for some of the genotypes are significantly different. However maximum number (13.5) of tiller per plant was observed in genotypes 118 and 119 followed by genotypes 109 and 123 having 13 tillers per plant. Minimum number (9.5) of tillers was observed in genotype 122. Genotype 132 showed 10.5, genotype 117 showed 11, genotypes 101, 108, PS-05, 110, 112 and 120 showed 11.5, genotypes 105, 113, 115, Siran and A-Habib showed 12 tiller per plant and genotypes 107 and 126 showed 12.5 number of tillers per plant (Table 1).

3.4 Spike Length (cm)

Spike length varied greatly among the wheat genotypes with observed means ranging from 9.2 to 14.5 cm. Maximum spike length of 14.5 cm was recorded by genotype 105 followed by genotype 108, 110 and 112 having spike length of 14 cm,13.8 cm and 13.5 cm respectively. Minimum spike length (9.2 cm) was recorded by genotype 117, 119, 126 followed by genotype 122 and A-Habib having 9.3 and 9.5 cm spike length. Among the remaining genotypes; genotype 123 and 132 showed 10 cm, 107 showed 10.2 cm, PS-05 showed 10.4 cm, 113 and Siran showed 10.8 cm, 101 showed 11 cm, 109 showed 11.2 cm, 120 showed 11.8 cm, 118 showed 12.5 cm and 115 showed 13 cm spike length. The LSD value for Spike length was 1.324 at α (alpha) level 0.05 (Table 1).

3.5 Number of Grains per Spike

Results of the present study showed significant variation in number of grain per spike with

observed means ranging from 67.5 to 95 grains. Numbers of grains per spike among 20 genotypes showed that line 105 have maximum (95) grains per spike followed by the genotype 108 and 112 having 94 and 89.5 grains per spike respectively. The check variety A-Habib, Siran and PS-05 showed (78 grains), (73 grains) and (68.5 grains) number of grains per spike respectively. Minimum number of grain per spike were observed in 132 (67.5 grains) followed by genotype 109 (68.5 grains) and genotype 107 (69 grains). Other genotypes recorded number of grains per spike as 119 (70 grains), 113 and 126 (72.5 grains), 123 (73 grains), 101 (75 grains), 117 (80 grains), 120 (80.5 grains), 115 and 118 (85 grains), 110 (87 grains) and 112 (89.5 grins) per spike. The LSD value for number of grain per spike was 5.007 at α (alpha) level 0.05 as shown in Table 1.

3.6 1000 Grain Weight (gm)

Wheat genotypes showed significant differences for 1000 grain weight ranging from 40 to 60 gms. Among all the genotypes maximum 1000 grain weight (60 gm) was showed by genotype 132. The genotypes Siran and PS-05 showed 50 gms and A-Habib showed 40 gms 1000 grain weight. Minimum grain weight 40 gms was recorded by genotype 101, 107, 109, 113, 117, 119, 122 and A-Habib. Thousand grain weight was recorded by the remaining genotypes as; 120 (44 gms), 123 (45 gms), 115 (46 gms), 118 (47 gms), 110 (48 gms) and 105, 108, 112 and 126 (50 gms). The LSD value for 1000 grain weight was 8.062 at α (alpha) level 0.05 (Table 1).

3.7 Grain Yield (kg ha^{-1})

The statistical analysis showed significant differences among all the genotypes in terms of grain yield per hectare. Maximum grain yield (5825 kg ha^{-1}) was observed in genotype 105. The genotype PS-05 showed (4633 kg ha^{-1}), Siran showed (4333 kg ha^{-1}) and A-Habib (5033 kg ha^{-1}) grain yield per hectare. Minimum grain yield per hectare was showed by genotype 126 with (2667 kg ha^{-1}) grain yield per hectare as shown in Table 1. Genotype 109 showed (3017 kg ha^{-1}), 132 showed (3183 kg ha^{-1}), 107 showed (3200 kg ha^{-1}), 123 showed (3366 kg ha^{-1}), 101 and 112 showed (3383 kg ha^{-1}), 119 showed (3656 kg ha^{-1}), 122 showed (3817 kg ha^{-1}), 117 showed (3917 kg ha^{-1}), 113 showed (4133 kg ha^{-1}), 120 showed (5067 kg ha^{-1}), 118 showed (5300 kg ha^{-1}), 115 showed (5522 kg ha^{-1}), 110 showed (5567 kg ha^{-1}) and 108 showed (5666 kg ha^{-1}) grain yield per hectare. The LSD value for grain yield per hectare was 1.401 at α (alpha) level 0.05 (Table 1).

3.8 Correlation Analysis

The result obtained from correlation analysis presented in Table 2, showing the relationship among all the parameters in the observed lines. Results of the correlation analysis showed positive significant (*) or highly significant (**) correlation between days to germination with number of tillers (.552*), Spike length with number of grain per spike (.845**), and grain yield/Hectare (.660**) similarly number of grain per spike have highly significant correlation with grain yield/hectare (.716**) as shown in Table 2. While plant height showed negative highly significant correlation with number of grain per spike (-.917**), spike length (-.874**) and grain yield per hectare (-.673**).

The results showed positive non significant correlation for days to germination with 1000 grain weight (.289), spike length (.288), number of grain per spike (.206), and grain yield per hectare (.128). There was also positive non-significant correlation between spike length with 1000 grain weight (.352), and number of tillers (.035), number of grain per spike with 1000 grain weight (.228), and 1000 grain weight with grain yield/hectare (.139) and Grain yield/hectare with biological yield (.127) as shown in Table 2. On the other hand results also showed negative non-significant correlation between days to germination with plant height (-.219), plant height with number of tiller per plant (-.066), and 1000 grain weight (-.243), number of grain per spike with number of tiller (-.043), number of tillers per plant with 1000 grain weight (-.191) and grain yield/hectare (-.046) Table 2.

4. DISCUSSION

Progress of high and maximum yielding wheat variety has at all times been a major intend of wheat breeding programs all over the world. A great treaty of significance is specified to increase the wheat production to fulfill the demand of wheat food grain for the rising population. To meet local use necessities more efforts should be done to improve yield of wheat and its improved adaptation to a broad range of environment. To increase the yield production of wheat, there are two ways i.e moreover by carrying more land region under crop growing or by increase its yield per unit area. It is difficult to

increase area of cultivation due to other competitive rabi crops. The method is to obtain higher yield per unit area by the production of new high yielding varieties and better crop management [7].

Perfection in the majority of the location is more efficiently fulfilled on the basis of performance of yield components, which are strongly associated with the grain yield [9]. Grain yield plant^{-1} can be improved by the selection of genotypes having all the desired agronomic traits. Production of grain is a complex observable fact which involves a number of contributing aspects. These aspects influence the production of grain both directly and indirectly and the breeders are logically concerned in examining the range and type of relationships of such characters. Path coefficient and correlations analysis are reasonable steps to know the type of plant character.

Twenty wheat genotypes were studied in present research work in order to find out yield and yield associated traits performance of these lines under the agro climatic conditions of Mansehra. Seventeen genotypes along with three check varieties were analyzed for their comparative performance. Our results showed non-significant differences for days to germination (Table 1), the genotypes (101, 107, 109, PS-05, 110,112,113,115,119,123 and 126) recorded 9.5 days to germination. While for genotypes (105, 108, 117, Siran, 118, 120, 122 and 132) recorded 10 days to germination. Results of the correlation analysis showed significantly positive correlation between days to germination with number of tillers, plant height with harvest index, Spike length with number of grain per spike, Spike length with grain yield/hectare and number of grain per spike with grain yield/hectare. These results are in agreement with the findings of Ihsanullah and Muhammad [10] who find significant variations among wheat genotypes for days to 50% headings.

Plant height (Table 1) varied significantly among wheat genotypes. Maximum plant height of 102.8 cm was recorded in genotype Siran followed by genotype 132 with plant height of 101.6 cm. Minimum plant height (65.6 cm) was recorded by genotype 105. Similar result for significant variation in plant height was also observed by Khan, [11] and Inamullah et al. [12] and Donmenz et al. [13] who reported that plant height showed highly significant differences among wheat genotypes. The difference in plant height may be due to most favorable interaction between environment and genotype. Plant height showed negative highly significant correlation with number of grain per spike, spike length and grain yield per hectare (Table 1). These results are contradictory to the results of Donmenz et al, [14] who observed significant correlation between plant height and grain yield.

The analyses of variance (Table 1) showed that the genotypes differ significantly for number of tiller per plant. The maximum number of tillers among all the twenty genotypes were produced by 118 and 119 (13.5) followed by genotypes 109 and 123 having (13) tillers per plant. The results are similar to Dautani et al. [14], who reported significant variation among the wheat genotypes. Minimum number of tiller per plant was observed in genotypes 122 (9.5) followed by 132 (10.5). The results are similar to Aliu and Fetahu [15] who also reported minimum number of tillers per plant in wheat genotypes. The production of maximum number of tillers may be due to the reason that genetic potential and climatic situation are positive for these wheat genotypes growth. Correlation analyses showed (Table 2) that number of tiller per plant is significant with days to 50% germination. These results are not in lined with the findings of Rana and Sharma [16] who found positive association of number of tillers and all the other traits.

Spike length showed significant variability among all the genotypes (Table 1). Genotype 105 showed the maximum spike length of (14.5cm) followed by genotype 108, 110 and 112 having spike length of (14 cm), (13.8 cm) and (13.5 cm) respectively. Whereas genotype 117, 119, 126 showed the shortest spike length (9.2 cm) followed by genotype 122 and A-Habib having (9.3 cm) and (9.5 cm) spike length. Our results agreed with Salimia and Atawnah, [17] who also observed significant variation in spike length of wheat genotypes. Correlation analysis reveals that spike length is non-significant with days to germination and heading while significant with plant height. The difference in spike length among the genotypes, maximum spike length may be due to environmental conditions of Mansehra which favored some of the wheat genotypes growth. Tammam et al. [18] also reported similar results from their research on wheat genotypes.

Variation in number of grain per spike in present study was highly significant in wheat genotypes

(Table 1). Maximum number (95) of grains per spike was recorded for genotype 105 followed by the genotype 108 having 94 grains per spike, whereas minimum number of grain per spike were observed in 132 (67.5 grains) followed by genotype 109 (68.5 grains) and genotype 107 (69 grains). These finding are in line with those of Husnain et al. [19] who also observed significant variation in number of grains per spike. Difference in grain number per spike in dissimilar agro climatic environment was also reported by Chawdhary [20]. They found that the grains number per spike have the mainly important effect on grain yield. The difference in grains number per spike may be due to environment and genomic potential difference. Our results are also in agreements with the results obtained by Khakwani et al. [21] who studied various wheat genotypes and found similar type of result.

Correlation analysis revealed that number of grains per spike showed highly positive significant correlation with spike length. While it showed highly negatively significant correlation with plant height. These results are in agreement with Maric et al. [22] who also reported significantly positive correlation numbers of grains per spike with spike length.

Table 1. Analysis of variance and LSD test for morpho-physiological traits of wheat genotypes

S. no	Var	D50%G	PH	NTP	SL	NGS	TGW	GY
1	101	9.5	94.20G	11.5CD	11.00FG	75.00FGH	40.00C	3383L
2	105	10	65.00M	12BC	14.50A	95.00A	50.00B	5825A
3	107	9.5	94.50G	12.5ABC	10.20GHI	69.00IJ	40.00C	3200M
4	108	10	70.30L	11.5CD	14.00AB	94.00AB	50.00B	5666B
5	109	9.5	99.00CDE	13AB	11.20EFG	68.50IJ	40.00C	3017N
6	PS-05	9.5	97.60EF	11.5CD	10.40GHI	68.50IJ	50.00B	4633F
7	110	9.5	74.10K	11.5CD	13.80ABC	87.00C	48.00BC	5567C
8	112	9.5	70.80L	11.5CD	13.50ABC	89.50BC	50.00B	3383L
9	113	9.5	100.7BC	12BC	10.80FGH	72.50HIJ	40.00C	4133H
10	115	9.5	77.0J	12BC	13.00BCD	85.00CD	46.00BC	5522C
11	117	10.3	98.11DE	11DE	9.200I	80.00DEF	40.00C	3917I
12	SIRAN	10	102.8A	12BC	10.80FGH	73.00GHI	50.00B	4333G
13	118	10	80.10I	13.5A	12.50CDE	85.00CD	47.00BC	5300D
14	119	9.5	90.10H	13.5A	9.210I	70.00HIJ	40.00C	3656K
15	120	10	80.70I	11.5CD	11.80DEF	80.50DE	44.00BC	5067E
16	122	10	99.40CD	9.5DE	9.300FGHI	71.50HIJ	40.00C	3817J
17	123	9.5	100.1BC	13AB	10.0I	73.00GHI	45.00BC	3366L
18	126	9.4	95.80FG	12.5ABC	9.220I	72.50HIJ	50.00B	2667o
19	132	10	101.6AB	10.5CDE	10.00GHI	67.50J	60.00A	3183M
20	A-HABIB	9	91.50H	12BC	9.500HI	78.00EFG	40.00C	5033E
LSD Value		0.000	1.890	0.000	1.324	5.007	8.062	85.82

Var=varieties, D50%G=days to 50% germination, PH=plant height, NTP=number of tillers per plant, SL=spike length, NGS=number of grains per spike, TGS=thousand grains weight, GY=grain yield, LSD=least significant difference

Table 2. Correlation analysis of wheat genotypes among various morphological parameters

	D50%G	PH	SL	NGS	NTP	TGW	GYH
D50%G	1						
PH	-.219 ^{ns}	1					
SL	.288 ^{ns}	-.874**	1				
NGS	.206 ^{ns}	-.917**	.845**	1			
NTP	.552*	-.066 ^{ns}	.035 ^{ns}	-.043 ^{ns}	1		
TGW	.289 ^{ns}	-.243 ^{ns}	.352 ^{ns}	.228 ^{ns}	-.191 ^{ns}	1	
GYH	.128 ^{ns}	-.673**	.660**	.716**	-.046 ^{ns}	.139 ^{ns}	1

**.Correlation is significant at the 0.05 level, **. Correlation is significant at the 0.01 level, ns = non significant, D50%G = days to 50% germination, PH = plant height, SL = spike length, NGS = number of grains per spike, NT = number of tillers per plant, TGW = 1000 grains weight, GYH = grain yield per hectare*

Significant variation was showed by 1000 grain weight among all the selected genotypes (Table 1). Among the selected genotypes highest 1000 grain weight (60 gm) was recorded by genotype 132 while lowest grain weight (40 gm) was showed by genotype 101, 107, 109, 113, 117, 119, 122 and A-Habib. Our results are similar with those of Ghaffar et al. [23] and Husnain et al. [19] who obtained similar type of results. Correlation analyses present that 1000 grain weight is non-significant with all parameters.

The analysis variance for grain yield showed significant variation among all the genotypes (Table 1). Genotype 105 recorded the highest (5825 gm) grain yield per hectare whereas genotype 126 recorded the lowest (2670 gm) grain yield per hectare. This result is similar to those of Inamullah et al. [12] and Ghaffar et al. [23] who also found significant differences for grain yield among wheat genotypes. The difference may be due the interaction between environment that effects the development and growth of the wheat which affects the morphology and phenology of the wheat lines [12]. Correlation analyses showed that grain yield per hectare is highly positive significantly correlated with spike length, and number of grain per spike as the spike length increases more will be the number of grains per spike which results in increase in grain yield while highly negative significantly correlated with plant height. Increase in plant height will decrease the spike length and the number of grains per spike, which results in decrease in grain yield per hectare. These results are in agreement with the results of Palta et al. [24] who also found positive and significant correlation between grain yield and spike length.

The genotypes 105, 108, 110, 115, 118 and 120 performed well under the agro-climatic conditions of Mansehra and produced maximum grain yield (5825 kg ha^{-1}, 5666 kg ha^{-1}, 5564 kg ha^{-1}, 5522 kg ha^{-1}, 5300 kg ha^{-1} and 5067 kg ha^{-1} respectively as compared to the check varieties PS-05 (4633 kg ha^{-1}), Siran (4333 kg ha^{-1}) and Atta-Habib (5033 kg ha^{-1}) respectively. Due to high grain yield performance the genotypes 105, 108, 110, 115, 118 and 120 are selected and recommended for cultivation in Mansehra and other similar climatic areas.

5. CONCLUSION

A positive and highly significant correlation was observed among spike length, number of grain per spike and grain yield/Hectare. While plant height showed negative and highly significant correlation with number of grain per spike, spike length and grain yield per hectare. As the genotypes 105, 108, 110, 115, 118 and 120 performed well under the agro-climatic conditions of Mansehra and produced maximum grain yield (5825 kg ha^{-1}, 5666 kg ha^{-1}, 5564 kg ha^{-1}, 5522 kg ha^{-1}, 5300 kg ha^{-1} and 5067 kg ha^{-1} respectively as compared to the check varieties PS-05 (4633 kg ha^{-1}), Siran (4333 kg ha^{-1}) and Atta-Habib (5033 kg ha^{-1}) respectively. Due to high grain yield performance the genotypes 105, 108, 110, 115, 118 and 120 are selected and recommended for cultivation in Mansehra and other similar climatic areas.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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