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Evaluation of Promising Wheat Advanced Lines for Maturity and Yield Attributes under Rainfed Environment

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Abstract: Development of high yielding and drought tolerant genotypes is one of the prime objectives of wheat breeding programs. In the present study a set of twenty wheat genotypes were screened for yield potential under rainfed environment during 2013-14 at Agriculture Research Station Swabi, Khyber Pakhtunkhwa, Pakistan. Genotypes were evaluated in randomized complete block design with three replications. Analyzed data revealed significant differences for days to heading, days to maturity, plant height, grains spike^{-1}, 1000-grain weight and grain yield among the tested genotypes. Mean values for days to heading, days to maturity, plant height, number of grains spike^{-1}, 1000-grain weight and grain yield ranged from 114 to 135 days, 167 to 172 days, 83 to 102 cm, 42 to 68, 28.7 to 44.6 g and 4111 to 7333 kg ha^{-1}, respectively. Based on average performance, AUP-0484 started heading earlier, AUP-3186, PS-18/MPT(RF)-2/7 and AUP-2670 took minimum (167 days) and maturing earlier than local check (Pirsabak-2005). Genotypes PS-20/MPT (RF)-2/4 and PS-20/MPT (RF)-2/4 produced maximum grains per spike. For 1000-grain weight Entry#-338 and PS-18/MPT (RF)-2/7 were found best. Although genotypes were tested on moisture stress environment (rainfed), but still PS-20/MPT (RF)-2/4 and NRL-1139 performed well than local check (Pirsabak-2005) and produced maximum grain yield (7333 and 6667 kg ha^{-1}, respectively). PS-20/MPT (RF)-2/4 and NRL-1139 have the genetic potential to produced high yield under rainfed environment. However, their results need to be confirmed over years and locations for conclusive recommendations. These lines could be used as a source of germplasm in future wheat improvement program for drought tolerance.

Key words: Bread wheat · Cultivars · Drought stress · Genetic potential · KPWYT (Khyber Pakhtunkhwa wheat yield trial)

INTRODUCTION

Wheat (*Triticum aestivum* L.*)* is the major staple food crop of Pakistan. Among wheat bread species, *Triticum aestivum* L., is cultivated most widely as food crop. In Pakistan, the contribution of wheat to value addition in agriculture is 10.1, while it contributes to growth demostic product (GDP) is 2.2 percent. The area under wheat cultivation increased to 8693 thousand hectares in 2012-13 from 8650 thousand hectares showing an increase of 0.5 percent over preceding year area under wheat. The production of wheat stood at 24.2 million tons during 2012-13 against the target of 25.5 million tons showing 5.1 percent decrease, while an increase of 3.2 percent over the last year production of 23.5 million tons. The yield per hectare in 2012-13 remained 2787 kg showing a positive growth of 2.7 percent as compared to negative 4.2 percent growth last year [1].

In many parts of the world water stress inhibited the wheat productivity. Developmental and growth phase is feasible rationale for the enhancement and improvement of wheat production. Drought stress conditions fluctuate in its effects and sternness with respect to the distribution and rate of precipitation, management and properties of

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soil. Wheat genotype that give maximum yield at optimum soil moisture and only display little decline in productivity in drought environment would reflect the efficiency and superior performance of that genotype.

Wheat yield in Pakistan is not sustainable and increase in wheat production is mostly proportionate to increase in area under wheat. Wheat yield varies mostly due to change in its contributing characters because yield per unit area is the product of several contributing factors including traits related to growth attributes, number and weight of grains. However, wheat yield can be increased through development of productive genotypes adapted to diverse agro-climatic conditions and resist biotic and abiotic stresses. Wheat occupies 70% of the Rabi and 37% of the total cropping area in Pakistan. It contributes 72% of the total calories intake, as its per capita consumption is 125 kg year^{-1} in Pakistan. In Khyber Pakhtunkhwa the total area under cultivation is about 1.92 million hectares out of which 1.2 million hectares comprises of dry land farming which is more than 60%. The total area under wheat in Khyber Pakhtunkhwa is 0.72 million hectares out of which 57% (0.41 million hectares) of cultivated area is rainfed. The annual rainfall varies from less than 250 mm in D.I Khan to over 1000 mm in Abotabad which are the un-irrigated areas in Khyber Pakhtunkhwa. The climatic conditions of southern and central Khyber Pakhtunkhwa are suitable for spring wheat production. However, winter wheat can also be grown in upper areas of Khyber Pakhtunkhwa like Swat, Chitral and Gilgit etc, where snowfall occur during winter season. But due to the improper crop management and insufficient knowledge about nutrients and their application, the farmers of this area are still unable to obtain optimum yield of wheat.

In Pakistan, among all the four provinces the average wheat yield is the lowest in Khyber Pakhtunkhwa. One major reason is the late maturity of maize, sugarcane and rice crops, on the same piece of land which leads to late sowing. In wheat late sowing drastically reduced grain yield and overall productivity of genotypes [2, 3]. Another major reason is that 57% of the area of wheat cultivation in Khyber Pakhtunkhwa is rainfed. The growers have to wait for rainfall so that the soil get proper moisture required for seed germination. In present circumstances, varieties suitable for rainfed conditions are the need of growers to avoid yield losses due to drought. The present study was undertaken with the objectives (i) to evaluate different advanced wheat lines under rainfed environment of district Swabi. (ii) To identify and select high yielding and drought tolerant line suitable for rainfed areas and to be used in future wheat improvement programs.

MATERIALS AND METHODS

Breeding Material and Field Experiment: Breeding material consisted of eighteen wheat advanced lines developed for rainfed environment by different Agricultural Research Institutes in Khyber Pakhtunkhwa. These eighteen lines along with two checks (Shahkar-2013 Pirsabak-2005) were tested in KPWYT (Khyber Pakhtunkhwa Wheat Yield Trial) under rainfed condition at Agriculture Research Station, Gulo Dheri (Swabi) during the 2013-14. Genotypes were evaluated in randomized complete block design with three replications. Each advanced line was sown 5 meter long having 6 rows and each row spaced 0.30 meter apart. The plot area was 9 m^2. Nitrogen was applied at the rate of 60 kg ha^{-1} in the form of urea, while phosphorous was applied at the rate of 30 kg ha^{-1} in the form of single superphosphate (SSP). Fertilizers were applied once to the field at sowing time.

Data Recording and Statistical Analysis: Data were recorded on the days to heading, days to maturity, plant height and number of grains spike^{-1}, 1000-grain weight and grain yield. Data recorded were analyzed statistically following appropriate method using computer software Statistix 8.1. Means were separated using Least Significant Difference (LSD) test.

RESULTS AND DISCUSSION

Days to Heading: Plant breeders are interested to develop new lines starts heading earlier. Data regarding days to heading were significantly affected among the cultivars as shown in the Table 1. Days to heading ranged from 114 to 135 days. Among the 20 cultivars minimum days to heading of 114 were taken by wheat cultivar AUP-0484, whereas maximum days to heading of 135 were recorded for cultivar Entry#-338 followed by PS-20/MPT (RF)-2/4 which took 134 days to 50% heading. Data indicated that some cultivars headed earlier than others which were in conformity with the findings of Rafiullah *et al*. [4] and Khan *et al*. [5] who also they reported significant difference for days to heading in wheat lines.

Days to Maturity: Plant breeders are interested in development of new genotypes which mature earlier. Maturity period is one of the important trait that help genotypes in different ways to cope with various abiotic and biotic stresses. Early maturing genotypes could escape heat and drought stress by completing their life cycle earlier. Data showed significant differences among the cultivars for days to maturity as shown in the Table 1. Days to maturity varied from167 to 172 days. Among the tested genotypes minimum days to maturity 167 were

Table 1: Mean values for maturity traits and plant height of twenty wheat genotypes evaluated under rainfed environment during 2013-14.

Genotypes	Days to heading	Days to maturity	Plant height
NRL-1123	132 bc	171 abc	98 a-e
NRL-1009	128 def	170 a-d	93 d-i
NRL-1130	132 bc	168 c-f	95 b-g
NRL-1139	131 bc	169 b-f	93 c-i
NRL-1241	132 bc	171 abc	100 abc
AUP-3186	122 g	167 ef	93 d-i
Entry#-338	135 a	172 a	100 ab
DN-102	132 bc	171 abc	88 g-j
DN-104	130 cd	171 ab	96 a-e
PS-17/MPT(RF)-2/8	126 ef	170 a-d	96 a-f
PS-18/MPT(RF)-2/7	122 g	167 ef	88 hij
PS-19/MPT(RF)-1/6	132 bc	170 a-d	93 c-i
PS-20/MPT(RF)-2/4	134 ab	171 a	94 b-h
PS-21/MPT(RF)-2/16	125 f	170 a-e	89 f-j
AUP-0484	114 h	168 def	87 ij
AUP-2670	122 g	167 f	99 a-d
BAFFA-3/107	131 bc	169 a-f	92 e-i
BAFFA-4/108	131 bc	171 ab	93 d-i
Shahkar 2013 Check-I	130 cd	168 c-f	83 j
Pirsabak-2005(Check-II)	128 de	171 a	102 a
$LSD_{(0.05)}$	2.87	2.45	6.98

Mean values followed by different letters are significantly different from each other

Table 2: Mean values for yield and yield related traits of twenty wheat genotypes evaluated under rainfed environment during 2013-14

Genotype	Grains spike^{-1}	Grain yield	1000 grains weight
NRL-1123	56 cde	5889 a-d	34.5 fg
NRL-1009	50 d-h	5333 bcd	40.3 bcd
NRL-1130	50 e-h	6111 abc	41.2 abc
NRL-1139	51 c-g	6667 ab	36.4 def
NRL-1241	58 cde	5556 a-d	35.0 fg
AUP-3186	59 bc	6500 ab	40.2 bcd
Entry#-338	53 c-f	6278 abc	44.6 a
DN-102	51 c-f	5500 a-d	32.1 gh
DN-104	53 c-f	4111 d	28.7 h
PS-17/MPT(RF)-2/8	50 d-h	5167 bcd	35.8 efg
PS-18/MPT(RF)-2/7	43 gh	4389 cd	44.3 ab
PS-19/MPT(RF)-1/6	55 cde	5722 a-d	38.2 c-f
PS-20/MPT(RF)-2/4	67 ab	7333 a	34.3 fg
PS-21/MPT(RF)-2/16	68 a	5722 a-d	39.6 cde
AUP-0484	42 h	5444 a-d	37.4 c-f
AUP-2670	45 fgh	6056 abc	40.1 cd
BAFFA-3/107	53 c-f	6444 ab	35.5 efg
BAFFA-4/108	58 cd	6222 abc	35.7 efg
Shahkar 2013 (Check-I)	58 cde	5389 bcd	37.5 c-f
Pirsabak-2005(Check-II)	51 c-h	6500 ab	40.0 cd
$LSD_{0.05}$	8.35	1937.6	4.13

Mean values followed by different letters are significantly different from each other

taken by wheat cultivar AUP-2670 followed by AUP-3186 and PS-18/MPT (RF)-2/7, whereas maximum days to maturity of 172 days were recorded for Entry#-338. Data suggests that cultivar belongs to different maturity groups which were confirmed by early studies of Ishaq *et al*. [6] and Ahmad *et al*. [7].

Plant Height: Plant breeders are interested in development of new genotypes having short stature because of their lodging resistance and positive response to chemical fertilizers and irrigation. Results revealed that significant differences among the cultivars for plant height (Table 1). For plant height data varied from 83 to

102 cm. Among the 20 cultivars minimum plant height (83 cm) was recorded for Shahkar-2013 followed by AUP-0484 which has height of 87cm, whereas maximum plant height (102 cm) was observed for check cultivar Pirsabak-2005. Significant genotypic variations for plant height in wheat have been reported by Abbasi *et al*. [8] and Afridi *et al*. [9].

Grains spike^{-1}: Data regarding grains spike^{-1} were significantly affected among the cultivars as shown in Table 2. Grains spike^{-1} ranged from 42 to 68. Among the 20 cultivars minimum grains spike^{-1} were recorded 42 at AUP-0484, whereas maximum grains spike^{-1} (68) were recorded for PS-21/MPT (RF)-2/16 followed by cultivar PS-20/MPT (RF)-2/4 which have 67 grains per spike. Data indicates variations among cultivars for the grains spike^{-1}. Our results are in conformity with findings of Khan *et al*. [5] and Ahmad *et al*. [7] and they found significant variability among the tested wheat lines for grains spike^{-1}.

Thousands Grains Weight: Thousand kernel weights is important yield contributing trait and are given more emphasis during cultivar selection process. Yield of wheat can be increased by increasing grain weight Recorded data showed significant variation among the lines for 1000 grains weight. 1000 grains weight ranged from 28.7 to 44.6 g. Among the 20 cultivars minimum grain weight (28.7 g) was recorded for at DN-104, whereas maximum 1000 grains weight of 44.6 g was recorded for Entry#-338 followed by PS-18/MPT(RF)-2/7 (44.3 g) (Table 2). Data indicates variability among lines which were in conformity with Abassi *et al*. [8] and Nasir *et al*. [10].

Grain Yield: Grain yield is important parameter and plant breeders are interested in evolving new genotypes having high yield. Data showed significant differences among the cultivars for grain yield (Table 2). Grain yield varied from 4111 to 7333 kg ha^{-1}. Under moisture stress condition among the 20 cultivars the minimum grain yield were recorded for D N-104 (4111 kg ha^{-1}), followed by PS-18/MPT(RF)-2/7 (4389 kg ha^{-1}), whereas genotypes PS-20/MPT (RF)-2/4 and NRL-1139 produced higher grain yield (7333 and 6667 kg ha^{-1} respectively) as compared to local checks. Data indicated that variation in grain yield production under rainfed environment Asif *et al*. [11] and Sarkar *et al*. [13] also reported significant difference regarding grain yield in wheat lines.

CONCLUSION

Based on the above experiment it was concluded that genotypes PS-20/MPT (RF)-2/4 and NRL-1139 performed well than local check (Pirsabak-2005) and produced maximum grain yield 7333 and 6667 kg ha^{-1} respectively. PS-20/MPT (RF)-2/4 and NRL-1139 have the genetic potential to produced high yield under rainfed environment therefore; these lines could be used in future breeding programs to develop new wheat lines for rainfed environment.

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