International Journal of Agriculture and Crop Sciences.
Available online at www.ijagcs.com
IJACS/2015/8-02/249-255
ISSN 2227-670X ©2015 IJACS Journal

Adaptation Assessment of Some Wheat advanced lines in Kabul Agro-Ecological Conditions

Mohammad Wali Salari[1], Mohammad Bahman Sadeghi[1*], Kalimullah Saighani[1], Ahmad Fahim Samadi[2] and Wakil Ahmad Sarhadi[2]

1. Department of Biotechnology and Seed Production, Agriculture Faculty, Kabul University, Afghanistan
2. Department of Agronomy, Agriculture Faculty, Kabul University, Afghanistan

[*] ***Corresponding Author email:*** mbsadeghi1@gmail.com

ABSTRACT: this research was conducted to evaluate the performance of wheat advanced lines, developed by Purdue University small grain program, under Kabul agro-ecological conditions. The main objectives of this research were: to determine the superior genotypes that are adapted to Kabul agro-ecological condition and use them in future wheat breeding programs in Afghanistan.Random complete block design (RCBD).research farm and agronomy lab of Agriculture Faculty, Kabul University, 36 months.Eleven wheat advanced lines from Purdue University and three local varieties for checks from Kabul were tested for three years under Kabul agro-ecological conditions. Data were collected on grain yield and yield components. Analysis revealed a highly significant difference among genotypes for grain yield and the yield components. Analysis of variance of the 11 advanced lines and local varieties showed a highly significant genotype effect for all the studied traits. The most coefficient of determination observed between yield and kernel weight (R^2 = 0.53). To determine similarity and genetic distances between advanced lines and local varieties, cluster analysis by Ward method was used and all genotypes divided into 3 clusters similarity. Two of the advanced Purdue lines (SNOWMASS-01 and 112303-IN) performed well under- Kabul Agro-ecological conditions and yielded (t/ha) significantly higher than checks (2.79 and 2.62 t/ha).
Conclusion: With additional tastings, these potential lines could be released after for specific environments in Afghanistan similar to the Kabul agro ecology.
Key words: Advanced lines, Wheat, G and E interaction, Genotype, Adaptation.

INTRODUCTION

Afghanistan is a mountainous country with only about 12% of the land being suitable for farming and actually about 6% is being cultivated (USDA 2010; Khanzada, Raza et al. 2012). Wheat is the staple food crop in Afghanistan and is produced under both irrigated and rain-fed conditions (Khanzada, Raza et al. 2012). Currently it is planted on around 75% of the crop land of Afghanistan and accounts for approximately 70% of the Afghan people's annual caloric intake (Chabot and Dorosh 2007; Persaud 2010). A large proportion of the rural Afghan farming population is reliant upon wheat production for subsistence making it a primary source of income(Qureshi and Akhtar 2004). However, domestic wheat production has never been sufficient to meet the country's demand, necessitating additional importation from neighboring countries and various international development agencies (Persaud 2008). As of 2011, some 50% of the total wheat consumed in Afghanistan was imported. Despite these additional imports and the foreign aid being donated to the country, USAID estimates that over six million Afghans – nearly one-fifth of the population – do not have enough food. This has made Afghanistan highly vulnerable to food insecurity, and if the foreign food supply vanishes, the results will be disastrous (Persaud 2008). Lack of improved wheat seeds and well adapted varieties are the main constraints to wheat production sector in Afghanistan; other constraints are, low quality fertilizers, and lack of proper technology such as farm machinery. Addressing the problem of adaptability requires effective utilization of the germplasm resources including new introductions. However, any variety introduced into a new environment should be tested, at least for two years, and should be checked for adaptation. Improved wheat varieties may perform differently in diverse environments and the differences in their performance might be due to genetic by environmental interaction(Osmanzai and et al 2008). The genetic by environment interaction reduces correlation between phenotype and genotype making it hard to detect the genotypic effects of a variety (Osmanzai and Sharma 2008). For complex traits like yield that are conditioned by many genes, environmental influence on performance is often high. For this reason, wheat breeders need to conduct multi-environment performance tests on exotic wheat varieties in order to determine their adaptability and stability. Presence of G x E interactions is often an indication of lack of stability of genotypes across environments. However, presence of G x E can be exploited in the selection of genotypes that are adapted to specific environments (Crossa, Burgueño et al. 2006). In Afghanistan, limited research has been conducted on adaptability of wheat genotypes, and this has resulted in farmers growing varieties that are poorly suited to their environments, with eventual low yields. Previous studies on bread wheat in Afghanistan demonstrated the importance of G x E in genotypic selection (Osmanzai and Sharma 2008; Sharma, Morgounov et al. 2010, Siddiqui and Naz 2009). Particularly, Osmanzai and Sharma (2008), performed a multi environment evaluations of 49 spring wheat and found that genotypes performances were specific to environments. The authors identified five lines that yielded (4.5-5.7 t/ha) better than the checks which is much more in comparison to the 1.5 t/ha average national wheat yield in Afghanistan. These five lines then were released to farmers as new improved wheat varieties. In the current study, 11 different wheat advanced lines from USA were evaluated on the research farm of agriculture faculty at Kabul University. The objective of this study was to assess the important agronomic traits of these advanced lines and Afghan local varieties to identify the promising wheat genotype for wide and specific adaptation based on grain yield performance under Kabul agro-ecological conditions for use in wheat breeding programs in Afghanistan.

MATERIALS AND METHODS

Study site and plant materials

This study was conducted on Agricultural research stations in Kabul, Afghanistan during the three wheat successive growing seasons 2011-2012, 2012-2013 and 2013-2014. The genetic materials included eleven different advanced breeding lines developed by Purdue University small grain program and three local varieties adapted to diverse agro-ecological conditions of Afghanistan. These eleven advanced lines were SNOWMASS-01, 112303-IN, 112304-IN, 112306-IN, 112307-IN, 112308-IN, 112310-IN, 112311-IN, MILLENIUM-03, PD-4521-A-6 and PD-4746-A. These advanced lines developed by Purdue University had good agronomic characteristics and performed very well under Indiana agro-ecological conditions. Three local varieties were KOSHAN09 (control), CHONTE (control), APACHI (control). The three local varieties used in this experiment as checks, were obtained from cereal research department in ministry of agriculture, irrigation and livestock (MAIL), Afghanistan. The more descriptions of those advanced lines and local varieties are presented in Table 1.

Experimental design

The seeds were planted on 26 October 2011, 2012 and 2013 in a randomized complete block design (RCBD) with three replication. At each year the design consisted of three replications and 42 plots and each plot contained six rows and the distance between two rows was 25 cm. Plot size was 2 by 1.5 meter. Seed rate 45 g per plot; DAP and Urea used in each plot was 100 g and 50 g, respectively. The seeds were irrigated in the common method of the locality. Only the advanced lines and local varieties planted differed from one experimental plot to another and all other factors, such as fertilizers, insect control, and water management, were applied uniformly to all plots.

Data collection and analysis

Data were collected on agronomic characteristics such as yield, 1000 kernel weight, Kernels per spike, tilling capacity, plant height, spike length, and days to heading. Agronomic traits were measured on 15 plants in the center of the row and average values were used for analysis. GenStat statistical package was used to analyze the data. Analysis of variance is calculated using the model: $R_{ij} = \mu + G_i + Y_j + GY_{ij}$. Where Rij is the corresponding variable of the i-th genotype in j-th year, μ is the total mean, Gi is the main effect of i-th genotype, Yj is the main effect of j-th year, GYij is the effect of genotype x year interaction. In this model Y fixed and G is random. Correlation (r), regression coefficients (b) and coefficient of determination (R^2) of various traits in this research calculated. To determine similarity and genetic distances between advanced lines and local varieties, cluster analysis by Ward method was used.

RESULTS AND DISCUSSION

Statistical analysis according to the analysis of variance (ANOVA) for three successive seasons of randomized complete block design for studied traits are summarized in Tables 2. Based on the results obtained, statistical analysis revealed that the genotypes included in the study had highly significant variation ($p \leq 0.01$) for all traits under study. It could be concluded that differences between advanced lines and local varieties of wheat may be due to genetically differences between advanced lines and local varieties considerable amount of variation present in these material and revealing a high level of diversity among the cultivars for these traits. This provides evidence for sufficient variability and selection on the basis of these traits can be useful. The mean performances of advanced lines and local varieties have been provided in Table 3. Of particular interest, advanced lines SN0WMASS-01 and 112303-IN had higher mean yield performance than the others. Correlation analysis is widely used in statistical evaluations and it shows efficiency of relationship between two variables. According to the data presented in Table 4, the correlation coefficient (r values) for number of tillers per plant, number of kernels per spike, spike length (cm) and 1000-kernel weight were positively significantly correlated with yield (t/ha) indicating that increase in these characters would increase the yield (t/ha). When we look at the relationship among traits, the results of the correlation coefficients revealed that the number of tillers per plant, number of kernels per spike, spike length (cm) and 1000-kernel weight had the highest significant positive correlation with yield (t/ha), r= 0.703**, r=0.719**, r=0.739** and r= 0.734**, respectively (Table 4), indicating dependency of yield on these characters. Other traits including plant height and days to heading showed non-significant and negative 'b' values suggesting that yield would be decreased with the increase of both characters.

Based on simple regression analysis, linear regression of number of tillers per plant, number of kernels per spike, spike length (cm) and 1000-kernel weight it leads to increase the yield by 0.77, 0.42, 0.40 and 0.74 units, respectively. The coefficient of determination (R^2) revealed that about 53% of total variability in yield was due to its association with 1000-kernel weight. Aycicek and Yildirim (2006) reported that grain yield showed significantly positive association with number of productive tillers plant, plant height, 1000-grain weight and spike length at genotypic and phenotypic levels. Majumder, (2008) had shown that spikes number per plant, number of grains per spike, spike length and 1000-grain weight were the most important characters which possessed positive association with grain yield. However, Mohammed, (2009) showed a negative correlation between plant height and grain yield. Baloch, (2013) suggested that major portion of total variability in grain yield was attributable to traits such as tillers per plant, spike length and 1000-grain weight. To determine similarity and genetic distances between advanced lines and local varieties, cluster analysis by Ward method was used and all genotypes divided into 3 clusters similarity (Figure 1). First cluster included (112304-IN, 112308-IN, 112311-IN, CHONTE, MILLENIUM-03, PD-4521-A-6, 112307-IN and PD-4746-A), second cluster (112306-IN and 112310-IN) and third cluster included (112303-IN, ARIANA 94, SNOWMASS-01 and KOSHANO9). So beside advanced lines, Afghan varieties such as ARIANA 94 and KOSHANO9 are suitable for use in future of Afghan wheat breeding programs.

CONCLUSION

This study has shown the existence of considerable variation among the advanced lines under study. Results of the study showed that these advanced lines may provide good source of material for further breeding program. The multiple statistical procedures which have been used in this study showed that simple correlation and regression analysis cannot distinguish important variables affecting grain yield, the final judgment cannot be done on the basis of these methods as such, it is necessary to use multivariate statistical methods in breeding programs for screening important traits in wheat. An over all, it is logical to conclude that number of tillers per plant, number of grains per spike, and 1000-grain weight were the major contributors towards grain yield since these three characters had high correlation and also high direct effect thus direct selection for these three character should be major concern for plant wheat breeder. Hence using such devices will create opportunity to make better selection of suitable genotypes in wheat improvement programs and to get high yielding genotypes. The evaluations of improved wheat genotypes under Kabul agro-ecology indicated presence of large genetic diversity for grain yield and yield components. This is an indication that successful selection for further improvement can be made among these genotypes. Our data have isolated a three candidate lines that out yielded the check varieties. These lines included; SNOWMASS-01, 112303-IN, and 112304-IN. The measured yield components such as 1000 kernel weight, Kernels per spike, tilling capacity, plant height, spike length, and days to heading tended to show some correlation with grain yield. We suggested further analysis of these traits with additional experimental data to make justifiable conclusions.

Table 1. The descriptions of wheat advanced lines and local varieties used in this research (2011).

Advanced lines and local varieties	Accession number	Country	Growth Habit	Pedigree
SNOWMASS-01	PI-658597	USA:Colorado	W	KS-96-HW-94//TREGO/CO-960293[3682][3739]; KS-96-HW-94/CO-980352[3814]
112303-IN	PI-661099	USA:Indiana	W	ABN-1089-I-1/25-R-18//ABN-0128-G-5[2965]
112304-IN	PI-659821	USA:Indiana	W	25-R-18/25-R-47[2965]
112306-IN	PI-661102	USA:Indiana	W	25-R-58/WBP-0287-E-1//8302/25-R-57[2965]
112307-IN	PI-659822	USA:Indiana	W	WBP-0287-N-1/25-R-78//25-R-47[2965]
112308-IN	PI-659823	USA:Indiana	W	25-R-78/25-R-47//25-R-54[2965]
112310-IN	PI-661101	USA:Indiana	W	W-930259-A-1/25-R-49//(SIB)25-R-47[2965]
112311-IN	PI-661103	USA:Indiana	W	W-930966-B-1/W-930692-D-1//(SIB)25-R-47[2965]
MILLENIUM-03	PI-613099	USA:Nebraska	W	ARAPAHOE/ABILENE//NE-86488[1972][2414][2793]
PD-4521-A-6	CI-13290	USA:Indiana	W	PD-3369-63-4-1/PD-4126-A-9-32-2-1[424][1318]
PD-4746-A	AUS-3202	USA:Indiana	W	KNOX(SIB)/PD-4127-A-4-12-1[423][39]
KOSHANO9(control)	------	Afghanistan	S	BABAX/Lr42//BABAX*2/VIVITSI[3686]
ARIANA 94(control)	-----	Afghanistan	W	BOBWHITE/NACOZARI-76//VEERY/3/BLUEJAY/COCORAQUE-75 [1922]; CHINA-13/TEETER//GLENNSON-M-81[3589]
CHONTE(control)	------	Afghanistan	W	SERI.1B*2/3/KAUZ*2/BOBWHITE//KAUZ/4/PBW-343*2/KUKUNA[3692]

Table 2. ANOVA for seven traits of 14 wheat advanced lines and local varieties grown in 3 years under Kabul agro-ecological conditions (2011-2014).

Mean square								
SOV	df	Grain yield (t/ha)	1000-Kernel weight(g)	Kernels/spike	Tillers/plant	Plant height (cm)	Spike length (cm)	Days to heading
Genotype(G)	13	94.21**	78.31**	5.58**	1278.21**	373.42**	9.08**	210.49**
Year(Y)	2	23.15^{ns}	31.74^{ns}	3.66*	75.45^{ns}	90.45^{ns}	3.85^{ns}	30.22^{ns}
Replication	2	30.45^{ns}	25.41^{ns}	6.81*	120.21^{ns}	145.63*	4.02*	44.29^{ns}
G x Y	26	11.01^{ns}	9.87^{ns}	0.54^{ns}	67.14*	76.12^{ns}	0.98^{ns}	21.01^{ns}
Pooled Error	117	0.02	0.92	11.94	1.67	34.4	0.34	0.5

**Significant at the 0.01 level of probability; * Significant at the 0.05 level of probability, ns: not significant, in this ANOVA table, Y fixed and G random.

Table 3. Mean performance of fourteen wheat advanced lines and local varieties under Kabul agro-ecological conditions (2011-2014).

Advanced lines and local varieties	Grain yield (t/ha)	1000- kernel weight(g)	Kernels/spike	Tillers/Plant	Plant height (cm)	Spike length (cm)	Days to heading
SNOWMASS-01	2.79	43.63	29.83	10.33	100.33	7.17	202.67
112303-IN	2.62	47.52	39.60	10.00	106.00	8.57	201.33
112304-IN	1.58	37.21	30.93	9.00	79.00	7.63	199.33
112306-IN	1.78	40.10	34.30	7.33	90.00	8.90	193.33
112307-IN	1.42	37.45	42.80	8.00	72.67	7.17	204.67
112308-IN	1.31	35.04	38.00	10.67	78.33	8.27	200.33
112310-IN	1.80	40.69	37.57	10.33	86.00	8.13	193.33
112311-IN	1.37	32.95	35.23	10.33	79.87	8.23	199.67
MILLENIUM-03	1.33	32.52	41.57	8.67	79.00	8.50	198.67
PD-4521-A-6	1.41	35.80	41.63	9.00	82.67	9.23	205.33
PD-4746-A	1.40	37.50	47.33	11.33	76.00	9.00	200.67
KOSHANO9(control)	2.24	42.93	33.43	12.67	99.33	6.33	192.67
ARIANA 94(control)	2.35	41.78	31.63	11.67	105.33	6.07	198.33
CHONTE(control)	1.11	38.87	36.67	9.67	77.00	7.40	199.33

LSD (5%)	0.19	1.61	5.80	2.17	9.84	0.98	1.19
CV (%)	10.20	2.60	9.30	13.00	6.80	7.40	0.40

Table 4. Correlation (r), regression coefficients (b) and coefficient of determination (R2) of various traits in this research.

Character association	Correlation coefficient (r)	Regression coefficient (b)	Coefficient of determination (R^2)
Days to heading *vs* grain yield (t/ha)	-0.080^{ns}	-0.01	0.006
Plant height(cm) *vs* grain yield (t/ha)	-0.220^{ns}	-0.20	0.04
Number of tillers per plant *vs* grain yield (t/ha)	0.703**	0.77	0.49
Number of kernels per spike *vs* grain yield (t/ha)	0.719**	0.42	0.51
Spike length (cm) *vs* grain yield (t/ha)	0.739**	0.40	0.54
1000-kernel weight (g) *vs* grain yield (t/ha)	0.734**	0.74	0.53

**Significant at P < 0.01 and ns = non-significant according to the t-test, respectively.

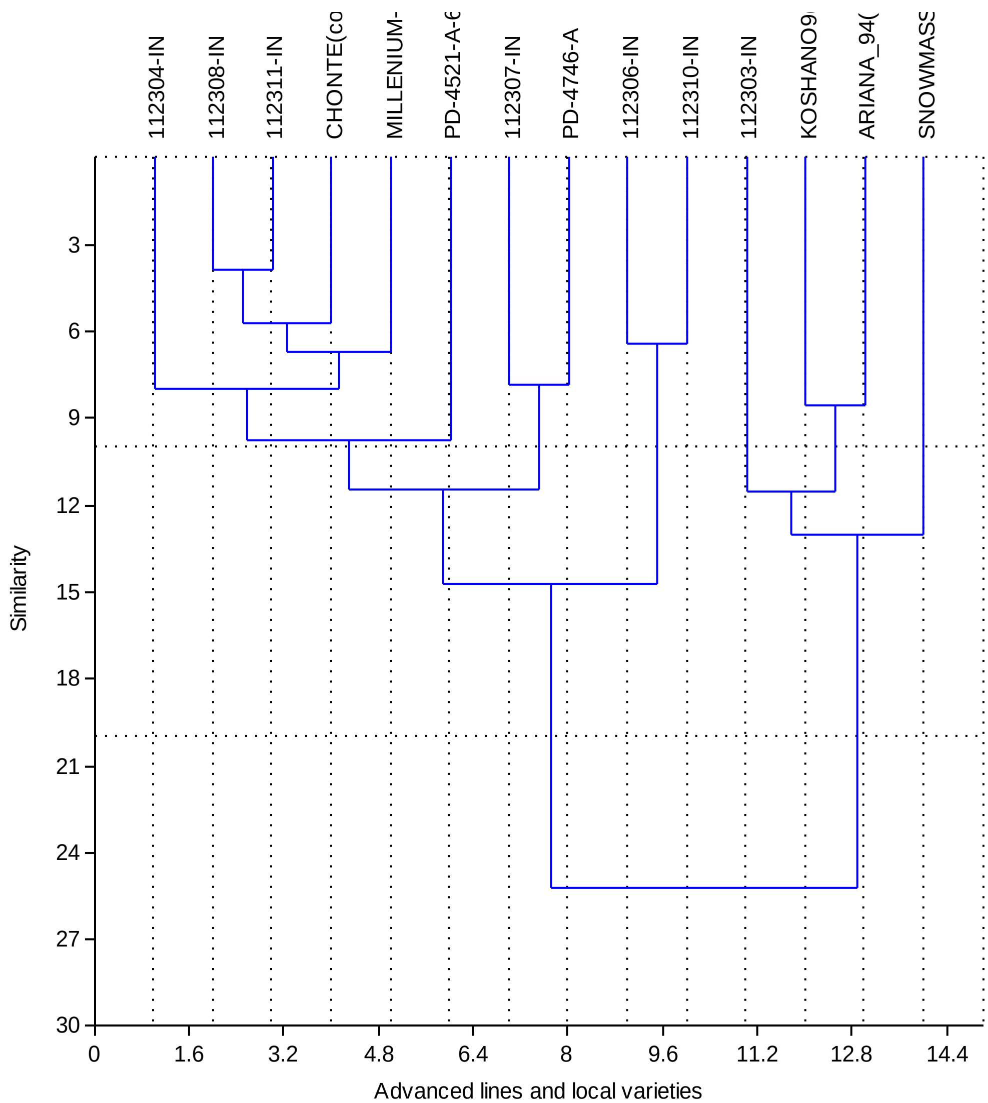

Figure 2. Determination of similarity and genetic distances between advanced lines and local varieties.

REFERENCES

Aycicek M, Yildirim T. 2006. Path coefficient analysis of yield and yield components in bread wheat (*Triticum aestivum* L.) genotypes. Pak. J. Bot., 38(2): 417-424.

Baloch MJ, Baloch E, Jatoi WA, Veesar N.2012. Correlations and heritability estimates of yield and yield attributing traits in wheat (*Triticum aestivum* L.). Pak. J. Agri., Agril. Engg., Vet. Sci. 29(2): 96-105.

Chabot P, Dorosh PA.2007. "Wheat markets, food aid and food security in Afghanistan." Food Policy 32(3): 334-353.

Crossa J, Burgueño J, et al. 2006. "Modeling genotype× environment interaction using additive genetic covariances of relatives for predicting breeding values of wheat genotypes." Crop Science 46(4): 1722-1733.

Khanzada SK, Raza A, et al. 2012. "Release ofelite linesin Afghanistan: futurethreatto sustainablewheat productioninAfghanistan." Pak. J. Phytopathol 24(1): 82-84.

Majumder D, Shamsuddin A, et al. 2008. Genetic variability, correlated response and path analysis of yield and yield contributing traits of spring wheat. J. Bangladesh Agril. Univ. 6 (2): 227-234.

Mohammed L. 2009. Study of inter correlation among yield and its components of some genotypes of bread Wheat (*Triticum aestivum* L.). Journal of Tikrit University. 9(1): 1-6.

Osmanzai M, Sharma RC, Ghanizada GH, Ahmadzada Z. 2008. Wheat rusts in Afghanistan: an assessment of occurrence and cultivar resistance. Karna 39(2):3-6.

Osmanzai M, Sharma RC. 2008. "High yielding stable wheat genotypes for the diverse environments in Afghanistan." International Journal of Agricultural Research 3(5): 340-348.

Persaud S. 2008. "Long-Term Growth Prospects for Wheat Production in Afghanistan." Growth 10(2): 41- 42.
Persaud SC. 2010. Price Volatility in Afghanistan's Wheat Market, US Department of Agriculture, Economic Research Service.
Qureshi AS, Akhtar M. 2004. A survey of drought impacts and coping measures in Helmand and Kandahar provinces of Afghanistan, Lahore & Tehran: International Water Management Institute.
Sharma RC, Morgounov AI, et al. 2010. "Identifying high yielding stable winter wheat genotypes for irrigated environments in Central and West Asia." Euphytica 171(1): 53-64.
Siddiqui M., Naz N.2009. Protein landmarks for diversity assessment in wheat Genotypes. African Journal of Biotechnology. 8 (9): 1855-1859.