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SCREENING AND EVALUATION OF WHEAT GERMPLASM FOR YIELD, DROUGHT AND DISEASE RESISTANCE UNDER RAINFED CONDITIONS OF UPLAND BALUCHISTAN

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Abstract

Eleven wheat genotypes in Micro-plot Wheat Yield Trial including two checks (AZRI-96 and local) were evaluated for drought, yield and disease resistance in order to incorporate the high yielding and disease resistant genotypes in our wheat breeding program. The experiment was conducted at Arid Zone Research Centre, Quetta under rainfed conditions during 2006-07. Micro-plot genotypes No. 1, 8 and 7 performed tremendously well as compared with the local checks. They produced significantly higher yield of 1345, 1307 and 1246 kg/ha with good drought resistance and higher resistance to stripe rust while the local check produced grain yield 1119 kg/ha and susceptible to yellow rust.

Introduction

Wheat is the most important cereal crop in the world. The area under its cultivation is approximately 7.08 million hectare with annual production of 18.227 million tones. Due to low average yield as compared to other advanced countries, breeders are interested to improve wheat crop to boost the productivity. This demands a constant vigilance as the genetic makeup of the wheat plant for having better combination of traits. Wheat is the most important crop in Balochistan and is the staple food of the people of the province like the people of the rest of the country. Thus wheat plays an important role in food security and poverty alleviation as a strategic crop and has an important role in economy (Anon., Cereal Annual Report 1998) ICARDA Aleppo, Syria.

Blum (1988) suggested that breeding for tolerance to drought involves combining good yield potential and the selection of traits that provide drought stress tolerance. Raja *et al*., concluded that simultaneous evaluation of the germplasm both under near optimum condition (To utilize high heritability and identify genotypes with high yield potential) and stress conditions (To preserve alleles for drought tolerance) is important to breed for higher yielding and drought tolerant genotypes. Behara (1994) reported that different genotypes of cereal respond differently in agro-climatic conditions of a particular area due to difference in their genetic makeup and physiological process. Selections of improved and high yielding genotypes of different cereals having a wide range of adaptation to agro climatic conditions are essential to increase yield per hectare. Therefore, attempts have been made by the agronomists, plant breeders and physiologists to improve growth, productivity as well as stability of production by combining different genes in a variety with improved agronomic technology, studying varietal characteristics that may enable cereal to yield more constantly under drought prone environments and evaluating and selecting more suitable drought tolerant cultivar. Mirza*et al*., (2003) concluded that improvement of 35to 50% in wheat yield has been achieved by the introduction of new high yielding cultivar in the country. It is the genetic makeup of a variety that is expressed by the favorable environment and produce different yields in different environments. Arid Zone Research Centre, Quetta has got the mandate to produce new high yielding drought, cold and disease resistant varieties that can be grown in the rainfed conditions of highland Balochistan.

Materials and Methods

The material was selected from CIMMYT, Mexico nurseries and tested against diseases and drought stress at Arid Zone Research Centre, Quetta during2006-07 growing season. Micro-plot Wheat Yield Trial comprised of eleven exotic wheat genotype including check (Table 1). The planting was carried out after applying a pre-planting soaking doze of approximately 50 mm, because of non-occurrence of rain. The experiment was laid out in randomized complete block design (Gomez & Gomez, 1983) with three replications. Each entry was planted with a single row hand drill in a four rows of 5 m long; having a row width of 25 cm. Nitrophos (23: 23) fertilizer was applied @ 23 kg/ha before sowing. All four rows were harvested for data collection. Plots were hand harvested. Parameter including days to 50% heading (from planting), plant height (cm) and yellow rust disease resistance (modified Cobb Scale) were recorded before harvesting. Production data (TDM yield kg/ha) grain yield kg/ha and 1000 grain weight (grams) were recorded after harvesting. Statistical analysis was conducted according to the standard procedures using MStat-C Statistical Software.

Results and Discussion

Plant height: Statistical analysis of the data showed significant differences ($P \leq 0.05$) among genotypes for plant height (Table 2).

Mean value of the data in Table 2 indicated that the higher plant height (72 cm) was obtained by entry No. 11 which also produced higher Total Dry matter followed by Entry. No. 1 which attained plant height of 68 cm while lowest plant height (53 cm) was produced by genotype No. 9 Ashiq*et al.*, (1995) reported that differences in plant height are due to the differences in their genetic makeup. The same result was reported by Hassan *et al.*, 1998. Since 1960, many semi-dwarf high yielding wheat varieties were released and its adaptation rate was very high till the early 1980 (Byerlee*et al.*, 1993) and (Heisay*et al*., 2002). In Pakistan tall varieties are mostly grown in rainfed areas where farmer need both grain and higher straw yield (Byerlee*et al.*, 1993) while these genotypes showed more drought tolerance as compared to dwarf genotypes. The Micro plot genotype No. 1 and 8 gave the maximum plant height and higher grain yield. These genotypes will be included in breeding program for rainfed areas in Baluchistan.

Days to heading: Difference among wheat genotype in the duration of the period between sowing and heading are largely governed by their sensitivity to photoperiod and vernalization (Slafer*et al.*, 1995). The number of days taken to 50% heading by the genotype under study showed significant differences (Table 2). The genotype No. 3, 4 and 8 took minimum number of 151 days to 50% heading. Early genotypes are favorable to escape late season drought. Genotypes No. 10 took maximum number of 160 days to produce 50% head followed by the genotype No. 6 which took 159 days to produce heads.

Table 1. Parentage, pedigree and origin of the Micro-plot Wheat Yield Trial.

Entry #	Parentage	Pedigree	Origin
1.	VEE/LIRA//BOW/3/BCN/4/KAUZ	CMBW89Y00834-OTOPM-48Y-010M-010SY-010M-OM-OSY-25Y	MX199-00-M9SAWYT-3
2.	CAZO/KAUZ/KAUZ	CMBW90Y3279-OTOPM-9Y-010M-010M-010Y-3M-015Y-0Y	MX199-00-M9SAWYT-8
3.	CROC_1/AE.SQUARROSA (224)//OPATA	CMBW91Y00935-80Y-11KBY-1KBY-010M-1Y-2M-0Y-0SY	MX199-00-M9SAWYT-10
4.	CROC_/AE.SQUARROSA (224)//OPATA	CMBW91Y00935-80Y-11KBY-1KBY-010M-1Y-3M-0Y-0SY	MX199-00-M9SAWYT-11
5.	CROC_/AE.SQUARROSA (224)//OPATA	CMBW91Y00935-80Y-11KBY-1KBY-010M-1Y-2M-0Y-0SY	MX199-00-M9SAWYT-12
6.	TZPP*2/ANE//INIA/3/CNO 67/JAR//KVZ/4/----	ICW91.0273-4AP-OTS-2AP-OTS-1AP-OL-OAP-OSY	MX199-00-M9SAWYT-27
7.	ALTAR 84/AE.SQ//2*OPATA	76SSD-OY-OSY	MX199-00-M9SAWYT-41
8.	TRACHA'S'//CMH76-252/PVN'S	ICW93-0065-6AP-0L-3AP-0L-1AP-0AP	
9.	W3918/Jup	CM39992-8M-7Y-0M-0AP	
10.	AZRI-96		
11.	Local		

Table 2. Mean values for plant height, days to heading, TDM, 1000 grain weight and grain yield.

Entry #	Plant height (cm)	Days to 50% heading	TDM kg/ha	1000 grain weight (g)	Grain yield kg/ha
1	68 ab	152 c	5666	25b	1345 a
2	63 bc	152 c	6266	21cde	1205 a
3	59 cd	151 c	6000	19de	677 cd
4	61 bcd	151 c	5400	18e	567 d
5	59 cd	152 c	6333	23bc	763 bcd
6	54 d	159 a	6333	23bc	1026 abc
7	58 cd	152 c	6533	22bcde	1246 a
8	65 abc	151 c	7933	25b	1307 a
9	53 d	156 b	6600	22bcd	981 abcd
10 AZRI-96	61 bcd	160 a	6666	30a	1010 abc
11 Local	72 a	156 b	8800	32a	1119 ab

Means in the same column followed by the same letters are not significantly different at $p \leq 0.05$

Grain yield: Higher Grain yield is the biggest reason for incorporating CIMMYT germplasm in wheat Breeding Program (Smale*et al.*, 1998). Significant differences ($p \leq 0.05$) were recorded for grain yield ($p \leq 0.05$). Maximum grain yield (1345 kg/ha), (1307 kg/ha) and (1246 kg/ha) was recorded by genotype No. 1, 8 and 7 respectively, followed by the genotype No. 6 (1205 kg/ha) while minimum grain yield (567 kg/ha) was produced by the genotype No. 4. Similar results are also supported by Muhammad *et al.* (1992) but contrary to that reported by Lopez & Richard (1994).

1000 grain weight: The weight of 1000 grain ranged from 18 to 25 g and lowest in entry No. 4. The heaviest grain was produced by entry No. 1 & 8 (25 g) which was followed by entries No. 5 & 6. (23 g). Entries No. 11 and No.10 were statistically identical for 1000 grain weight. The genotype having more 1000 grain wt also produced higher grain yield kg/ha which shows positive effect of grain wt on the total grain yield of the genotypes.

Total dry matter: Higher grain and straw yields are extremely important in highland Balochistan due to its erratic and unpredictable environment. Due to higher livestock population in highlands straw is the main source of feed in winter months for the livestock (December through February). Statistical analysis of the data revealed that biological yield was not significantly ($p \leq 0.05$) affected by the various genotypes of wheat. The maximum total dry matter of 8800 kg/ha was produced by entry No. 11 (Local check) followed by entry No. 8 which produced biological yield of 7933 kg/ha. While the minimum biological yield of 5400 kg/ha was recorded by entry No. 4 (Table 2). Similar results were also reported by Koler&Khristov (1984).

Disease reaction: One of the main objectives of this study is to develop wheat varieties which are resistant to strip rust and other diseases of highland Balochistan which inflict huge losses during wet years. In Balochistan strip rust/yellow rust (*Pucciniastriiformis*) inflicts losses in wheat production two to three years out of 10 years due to favorable conditions humid and cool (Sarfaraz*et al*., 1991). Genotypes in this experiment showed different level of susceptibility and resistance to stripe rust. Less than 10% (10 MS) strip rust infection has been reported as the highest resistance and less than 5% (5 MS) is the effective resistance of the wheat variety/line/gerrmplasm (Peterson *et al.*, 1948). Entry No. 2, 3, 4 and 11 showed high susceptibility to stripe rust. Entry No. 1, 8 and 10 (Improved check) showed resistant to strip rust and entry No.7 and 9 showed effective resistance (0-5 MS) to strip rust (Table 3). Entry No. 6 also showed high resistant to stripe rust. A major goal of most Wheat Breeding Programs is to develop resistant to diseases. Disease reaction is the second most important reason after grain yield for incorporating CIMMYT germplasm. Germplasm from CIMMYT may not only be evolved as promising variety of the future, but also as donor alleles to incorporate in our crossing program. Entry No. 1, 7 and 8 perform outstandingly in term of disease resistance and better grain yield, so these entries will be multiplied and tested in NUWYT for release as variety for highland of Balochistan and also for other highlands regions of Pakistan.

Table 3. Micro-plot germplasm and local check reaction to diseases.

Entry #	Resistance to strip rust		
	Replication No. 1	**Replication No. 2**	**Replication No. 3**
01	0	0	0
02	30 MS	40 MS	20 MS
03	20 MS	30 MS	25 MS
04	30 MS	40 MS	30 MS
05	0/10 MS	10 MR MS	10 MS
06	5 MS	10 MRS	0
07	0	5 MS	0
08	0	0	0
09	0	5 MS	0
10	0	0	0
11	40 MS	50 MS	25 MS

MSS: Moderately susceptible, MR: Moderately resistant, TMR: Traces of moderate resistance

References

Ahmed, S., A. Rodriguez, G.F. Sabir, B.R. Khan and M. Panah. 1991. Economic losses of wheat crops infested with yellow rust in highland Baluchistan: Survey Results. The MART/AZR Project, ICARDA No. 67: 1-15.

Anonymous.1999. Germplasm Programme cereal (Annual Report for 1998, ICARDA Aleppo, Syria.

Ashiq, H., S. Riaz, D. Muhammad and S. Khan. 1995. Grain yield, seed yield and quality of fodder as affected by various internal clipping in oats. *Sarhad J. Agric*., 11: 279-282.

Behera, A.K. 1994. Response of wheat (*Triticumaestivum* L.) varieties to sowing dates. *Ind. J. Agric*., 42: 247-253.

Blum, A. 1988.Heat tolerance. In: *Plant breeding for stress environments*. CRC Press. Inc., Boca Raton, F1.

Byerlee, D. and P. Moya. 1993. Impacts of international wheat breeding research in the developing world. 1966-1990. Mexico, D.F. CIMMYT.

Gomez, K.A. and A.A. Gomez. 1983. *Statistical procedures for agricultural research*. 2ndEdn., John Wily and Sons, New York.

Hassan, M.A., A.M.A. Kamal and M.R. Islam. 1998. A study on the management system of organic and inorganic fertilizers on the yield and yield components in wheat (*Triticumaestivum* L.). *Thai J. Agric., Sci.*, 31: 196-201.

Heisay, P.W., M.A. Lantican and H.J. Dubin. 2002. Impacts of international wheat breeding research in developing countries, 1966-1997. Special Report Mexico, D. F. CIMMYT.

Koler and Khristov. 1984. A note on the performance of new wheat varieties at different fertility levels under rainfed conditions. *Himachal J. Agric. Res*., 17: 108-109.

Lopez, C.C. and R.A. Richards. 1994. Variation in temperature cereals in rainfed environments. 1. Grain yield, biomass and agronomic characteristics. *Field Crops Res*., 37: 51-62.

Mirza, H., Wasiullah, J. Iqbal and M. Ilyas. 2003. Evaluation of wheat varieties under the agro-climatic conditions of Barani Agricultural Research Station, Kohat. *Pak. J. Agron*., 2(1): 8-12.

Muhammad, D., A. Hassan, S. Khan and M.S. Bhatti. 1992. Green forage yield, dry matter yield and chemical composition of oats with advance in maturity. *Pak. J. Agric*., 11: 279-282.

Peterson, R.F., A.B. Campbell and A.E. Hannah. 1948. A diagrammatic scale for estimating rust severity on leaves and stress of cereals. *Can. J. Bot. Sci*., 26: 496-500.

Rajaram, S., H.J. Braun and M. Van Ginkel. 1996. CIMMYT approach to breed for drought tolerance. *Euphytica*, 92: 147-153.

Slafer, G.A. and H.M. Rasuson. 1995. Photoperiod x temperature interaction in contrasting genotypes, time to heading and final leaf number. *Field Crops Res*., 44: 73-83.

Smale, M., R.P. Singh, K. Sayre, P. Pingoli, S. Rajaram and H.J. Dubin. 1998. Estimating the economic impacts of breeding non-specific resistance to leaf rust in modern bread wheat. *Special Report on Plant Diseases Mexico D. F. CIMMYT*, pp: 1055-1061.

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