Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.4, No.8, 2014

Performance Evaluation of Different Wheat Varieties under Agro-Ecological Conditions of Quetta (Balochistan)

Muzaffar Ahmed Longove[1], Farid Akbar[1], Shamsuddin Baqa[1], Hidayatullah[2] and Sher Azam[2]
1, Agriculture College Bulleli, Quetta, Balochistan
2, Lasbela University of Agriculture, Water and Marine Sciences Uthal, Balochistan
Corresponding Author Email: szehri10@gmail.com

Abstract
A field trial was conducted during the year 2012-13 to evaluate the performance of different wheat varieties under agro-ecological conditions of Quetta (Balochistan). The experiment was laid out in a three replicated Randomized Complete Block Design having net plot size of 5.0x1.2m (6.0 m^2) at the experimental fields of Agriculture Research Institute, Quetta. Five promising wheat varieties (Rakhshan-10, Zardana, Sariab-95, Rasco-2005 and Tijaban-10) were evaluated for their growth and yield performance. Variety Rasco-2005 surpassed all the varieties in this study for growth and yeid performance, followed by Zardana and Rakhshan-10. Rasco-2005 produced highest grain yield (5357.60 kg ha^{-1}), followed by Zardana (5157.60 kg ha^{-1}), Rakhshan-10 (5025.60 kg ha^{-1}), Tijaban-10 (4553.20 kg ha^{-1}) while lowest grain yield (4271.20 kg ha^{-1}) was recorded in Sariab-95. Hence, variety Rasco-2005, Zardana and Rakhshan-10 were the most promising varieties, while Tijaban-10 also showed promising performance and could be a good addition to the pipeline wheat varieties of Balochistan.
Keywords: Wheat, varieties, growth, biological yield, grain yield

INTRODUCTION

Wheat *Triticum aestivum* L., a leading cereal grain belongs to the gramineae family, is a staple food of billions of people in the world; used to make flour for leavened, flat and steamed breads, cookies, cakes, pasta, noodles and couscous; for fermentation to make beer and alcohol (Khan and Habib, 2003). Major cultivated species of wheat are *Triticum aestivum*, which is a hexaploid species and is widely cultivated in the world; *Triticum durum*, the only tetraploid form of wheat widely used today, and the second most widely cultivated wheat is *Triticum monococcum*, a diploid species with wild and cultivated variants; *Triticum dicoccum*, a tetraploid species, cultivated in ancient times but no longer has widespread use; and *Triticum spelta*, another hexaploid species is cultivated in limited quantities (Moon, 2008).

Pakistan is among top ten wheat producing countries of the world, but the average yield of the wheat is much lower than their potential yield. On the other hand, wheat requirements of the country are increasing due to rapid increase in population. According to Pakistan Economic Survey 2011-12, the contribution of wheat to value addition in agriculture is 12.5, while it contributes to GDP is 2.6 percent (GoP, 2012). Wheat yields in the country are 2714 kg ha^{-1} (2011-2012) as against 4762 kg ha^{-1} in China, world average is 3086 kg ha^{-1}, 3018 kg ha^{-1} in the USA and 2801 kg ha^{-1} in India. The area under wheat cultivation in Pakistan during 2011-12 was 8666 thousand hectares, showing a decrease of 2.6 percent over last year's area of 8901 thousand hectares. The production of 23.5 million tons was achieved during 2011-12 showing 6.17 percent decrease over the preceding year; while the yield per hectare was 2714 kg ha^{-1} showing 4.2 percent decrease over the last years yield ha^{-1}. This adverse trend in the area, grain production and yield per hectare was due to the fact that the sowing of wheat was delayed because of standing water and other climatic factors (GoP, 2012).

Development of new wheat varieties have resulted in remarkable increase in the yield per unit area worldwide. Varieties with different morphological and economic characteristics are now available as breeding stock (Parihar and Singh, 1995). Multi-environment trials are important in plant breeding and agronomy for studying yield stability and predicting yield performance of genotypes and agronomic treatments across environments (Vaughan and Judd, 2003). The differential response of genotypes to environmental changes is a genotype x environment interaction. Like the effects of genotypes, the effects of agronomic treatments (or any other management practices) can change differentially in relation to environmental changes, producing a environmental effects on wheat production (Smith, 1995). Statistical models are useful for treatment x environment. Agronomist use trials to compare combinations of agricultural production alternatives and make recommendations to farmers about the superior varieties and their stability across environments (Crossa *et al.*1999).

The agronomic performance of crop varieties and advanced lines could be evaluated by multi-environment trials (Yu, 1998), evaluating performance of wheat genotype under different environments and using different inputs (Voltas *et al.* 2005), yield and its component analysis (Piepho, 1995). The performance of wheat genotypes is mainly associated with the soil and climatic conditions, application of inputs and other management conditions (Piepho *et al.* 2004). The evaluation of elite wheat varieties and advanced lines is essential for the further improvement of wheat (Ozgen 1991 and Porfiri *et al.* 2001). Most previous studies were carried out by using a single method, and usually described the validity of methods and performance of trials, whereas the performances of genotypes in given environments were seldom reported. However, the performance of a genotype in a given environment is more important for wheat cultivation and improvement (Vaughan and Judd, 2003).

Each variety has a genotype-specific ability to maintain performance over a wide range of environmental conditions (Hancock, 2004). This ability is usually referred to as the sensitivity or adaptability of a variety. Such ability is an important property, because farmers naturally want to use varieties which perform well in their own fields (Bajaj, 1990). Assessing sensitivity has, however, proved difficult, because of problems involved in defining and measuring the wide diversity of natural environments. A key point is to use the conditional expectation of the yield given the environment as a latent explanatory variable (Bonjean and Angus, 2001). In this way the predicted yields of different varieties can be estimated at any expected environmental yield level (Ofversten, 2002). Demand for differential agronomic traits depends on the production environment of farmers and the extent to which they rely on genetic traits, rather than purchased inputs (Potts, 1996), to combat biotic and abiotic pressures. In marginalized regions of the world where a cooperative structure would enable farmers to gain revenues and reduce marketing costs, and consumer demand is localized, promoting cooperatives might also generate a positive externality of maintaining variety diversity (Nevo *et al.* 2002). To the extent that variety diversity also improves overall yield performance through genetic processes, it may also contribute to sustaining regional yield levels (Bela *et al.* 2006). In the present study, the performance of different wheat varieties was evaluated under agro-ecological conditions of Quetta (Balochistan)

MATERIALS AND METHODS

The experiment was laid out in a three replicated Randomized Complete Block Design having net plot size of 5.0x1.2m (6.0 m^2) at the experimental fields of Agriculture Research Institute, Quetta. Five promising wheat varieties such as: Rakhshan-10, Zardana, Sariab-95, Rasco-2005 and Tijaban-10 were evaluated. The recommended dose of NP fertilizers was applied, where all P (as mono ammonium phosphate) and 1/3rd of N (as urea) were applied at the time of sowing and remaining N was applied in two equal splits at first irrigation and at 2nd irrigation, respectively. The irrigations were applied according to the crop requirement and the weeding was performed by using weedicides. For recording observations on various agronomical traits, five plants in each plot were selected at random and labelled. After completion of observations on growth parameters, and when the crop reached its physiological maturity, the labelled plants were harvested manually and tied in small bundles, and were shifted to threshing yard. Threshing was performed manually; the grains were collected carefully to count and record.

Procedure for recording observations

Plant height (cm)

Plant height was recorded at maturity of the crop in randomly selected plants using measuring tape from bottom to tip of the spike in centimetres.

Tillers m^{-2}

Total tillers m^{-2} in each plot from three different locations were counted at the time of maturity and averaged.

Spike length (cm)

The length of all the spikes in randomly selected plants was measured in centimetres with measuring tap and average was worked out.

Spikelets spike^{-1}

The number of spikelets in each spike for all the randomly selected plants in each plot was individually counted and averaged.

Grains spike^{-1}

The number of grains in each spike of the randomly selected plants was counted at the crop maturity and average was worked out.

Seed index (1000 grain weight, g)

For recording seed index value, 1000 grains from all the randomly selected plants in each plot was collected at random and weighed in grams.

Biological yield (kg ha^{-1})

The all the foliage and grains received from each plot was weighed and on the basis of biological yield plot^{-1}, biological yield ha^{-1} was calculated in kilograms.

Grain yield (kg ha^{-1})

All the grain received from each plot was weighed and on the basis of grain yield plot^{-1}, grain yield ha^{-1} was calculated in kilograms.

The data were analyzed by Mstat-C following Russel and Eisensmith (1983).

RESULTS AND DISCUSSION

Plant height (cm)

The analysis of variance indicated that the plant height varied significantly (P<0.05) in different wheat varieties. Among wheat varieties, the plant height was maximum (97.50 cm) in variety Tijaban-10, followed by 92.01 cm and 90.52 cm plant height noted in varieties Rakhshan-10 and Sariab-95, respectively (Table-1). The plant height in variety Rasco-2005 was 90.05 cm and the minimum plant height of 88.31 cm was observed in variety Rasco-2005. This indicates that variety Tijaban proved to be one of the promising variety of the future in Balochistan as regards its plant height. These results are further supported by Yu (1998) who reported considerable variation in the plant height of different wheat varieties when planted under various environments. Biological diversity was observed in different wheat varieties and advanced lines under multi-environment trials by Ozgen (1993), Truberg and Huhn (2000), Truberg and Huhn (2002), Huhn and Truberg (2002), Wamatu and Thomas (2002), Voltas *et al.* (2005); while the growth response in varieties differed with the environmental conditions (Piepho 1995).

Tillers m^{-2}

The tillers m^{-2} varied significantly (P<0.05) in different varieties of wheat, and maximum tillers m^{-2} (347.17 m^{-2}) were noted in variety Rasco-2005, closely followed by varieties Zardana and Rakhshan-10 with 346 and 338.16 tillers m^{-2}, respectively. The tillers m^{-2} in variety Sariab-95 was 293.67 m^{-2} and the lowest number of tillers (263.67 m^{-2}) was noted in variety Tijaban-10. It was observed that Rasco-2005 was most promising wheat variety for cultivation under soil and climatic conditions of Quetta so far the number of tillers m^{-2} are considered. These results are further supported by Truberg and Huhn (2000), Huhn and Truberg (2002) and Piepho *et al.* (2004) who were of the opinion that the tillers m^{-2} is generally associated with genetic make of the parental material of different wheat varieties. These researchers have also reported varied response of varieties for the number of tillers m^{-2} in wheat.

Spike length (cm)

The spike length was influenced significantly (P<0.05) and different varieties of wheat varied markedly for their spike length. The spike length was highest (11.782 cm) in variety Rasco-2005, followed by varieties Zardana and Rakhshan-10 with average spike length of 11.222 cm and 11.422 cm, respectively. The spike length in variety Tijaban-10 was 11.404 cm and the lowest spike length of 9.782 cm was recorded in variety Sariab-95. Statistically the differences between Rakhshan-10, Zardana, Rasco-2005 and Tijaban-10 were non-significant (P>0.05) and significant (P<0.05) when compared with Sariab-95. It was observed that wheat variety Rasco-2005 showed its remarkable position in spike length under soil and climatic conditions of Quetta of Balochistan province. These results in relation to sopike length are in concurrence to those of Wamatu and Thomas (2002) and Voltas *et al.* (2005) who found that tillering capacity and spike length were genetically influenced by the breeding material for development of wheat cultivars developed in different environmental conditions.

Spikelets spike^{-1}

The analysis of variance illustrated that the differences in the spikelets spike^{-1} of wheat were significant (P<0.05) in different varieties. The highest number of spikelets (17.261) spike^{-1} was recorded in variety Rasco-2005, followed by varieties Zardana and Rakhshan-10 with 16.431 and 16.410 average number of spikelets spike^{-1}, respectively (Table-4). The number of spikelets in variety Tijaban-10 was 16.010 spike^{-1} and the lowest number of spikelets (15.010) spike^{-1} was recorded in variety Sariab-95. This suggested that all the varieties showed varied response for this trait; and wheat variety Rasco surpassed all the rest of varieties so far the spikelets spike^{-1} are concerned. The findings of the present research are further confirmed by Porfiri *et al.* (2001) who found that the varieties developed under different environments showed varied response for spikelets spike^{-1}.

Grains spike^{-1}

The varietal effect on the grains spike^{-1} was significant (P<0.05) and the results (Table-2) indicated that the maximum grains (40.334) spike^{-1} was recorded in variety Rasco-2005, followed by varieties Zardana and Rakhshan-10 with 37.166 and 35.611 grains spike^{-1}, respectively. The number of grains in variety Tijaban-10 was 35.444 spike^{-1}; while the lowest grains (33.111) spike^{-1} was recorded in variety Sariab-95. It was observed that variety Rasco performed better than all other wheat varieties tested in this experiment, but the differences between Tijaban, Rakhshan-10 and Zardana were non-significant (P>0.05) and significant (P<0.05) when comoared with Rasco-2005 and Sariab-95. These results are further supported by Vaughan and Judd (2003) who were of the experience that varieties developed under different environmental conditions possessed grains spike^{-1} in different number. Most previous studies were carried out by different researchers in different parts of the world from the performance trials of wheat cultivars have also supported by the findings of the present research in relation to grains spike^{-1}.

Seed index (1000 grains weight, g)

The analysis of variance suggested that the varieties differed significantly (P<0.05) in seed index value. The results in Table-2 indicated that the maximum seed index (46.056 g) was recorded in variety Rasco-2005, followed by varieties Zardana and Tijaban-10 with 42.456 g and 40.040 g seed index value, respectively. The seed index in variety Rakhshan-10 was 40.606 g; while the minimum seed index of 37.606 g was recorded in variety Sariab-95. It was observed that variety Rasco-2005 surpassed all other tested varieties regarding seed index value, while the performance of Rakhshan-10, Zardana and Tijaban-10 was also promising. These results are in line with those of Truberg and Huhn (2000) who found higher seed index in local varieties as compared to exotic cultivars; while Huhn and Truberg (2002) reported that varieties showed different seed index value, due to their genetic diversity.

Biological yield (kg ha^{-1})

The biological yield was significantly ($P<0.05$) different in varieties tested in this experiment and the maximum biological yield (12881 kg) ha^{-1} was recorded in variety Zardana, while Rasco-2005 and Rakhshan-10 produced average biological yield of 12877 kg and 12170 kg ha^{-1}, respectively. The biological yield in variety Tijaban-10 was 11740 kg ha^{-1}; while the minimum (11250 kg ha^{-1}) was recorded in variety Sariab-95. It was observed that biomass yield was markedly higher in Zardana, Rasco-2005 and Rakhshan-10 when compared with rest of the varieties tested. The higher biological yield under these varieties might be the result of genetic make of parental material of these lines, because all the varieties were provided with equal input and management conditions. These results are in accordance with the fidnigns reported by Dahleen *et al.* (1991) who reported varied quantities of total biomass for varieties developed in the diversified regions. Moreover, Pawar *et al.* (1990), Zhang *et al.* (1992) and Yagbasanlar and Ozkan (1995) have also supported the present results regarding the biological yield in different wheat varieties.

Grain yield (kg ha^{-1})

The grain yield ha^{-1} differed significantly ($P<0.05$) in various wheat varieties experimented in this study and the maximum grain yield (5357.60 kg ha^{-1}) was recorded in variety Rasco-2005, followed by varieties Zardana and Rakhshan-10 with average grain yield of 5157.60 kg and 5025.60 kg ha^{-1}, respectively. The grain yield in variety Tijaban-10 was 4553.20 kg ha^{-1}; while the lowest grain yield (4271.20 kg) ha^{-1} was recorded in variety Sariab-95. Although, the grain yield of Rasco-2005, Zardana and Rakhshan-10 was markedly higher than rest of the tested varieites, but Tijaban-10 also produced promising results. This higher grain yield might be associated with genetic make of parental material of these varieties, because under similar soil, climatic, input and crop management conditions, the grain yield diferred significantly. These results are in agreement with those of Wamatu and Thomas (2002) who reported marked difference in grain yield of wheat varieties developed in different ecologies; while Porfiri *et al.* (2001) reported that the grain yield of wheat varieties is mostly associated with the environmental conditions.

Conclusions

It was concluded that Rasco-2005 produced highest grain yield (5357.60 kg ha^{-1}), followed by Zardana (5157.60 kg ha^{-1}), Rakhshan-10 (5025.60 kg ha^{-1}), Tijaban-10 (4553.20 kg ha^{-1}) while lowest grain yield (4271.20 kg ha^{-1}) was recorded in Sariab-95. Hence, variety Rasco-2005, Zardana and Rakhshan-10 were the most promising varieties, while Tijaban-10 was also showed promising performance.

Table 1: Plant height, tillers m^{-2} and spike length of wheat varieties sown under soil and climatic conditions of Quetta (Balochistan)

Varieties	Plant height (cm)	Tillers m^{-2}	Spike length (cm)
Rakhshan-10	92.01 b	338.16 a	11.422 a
Zardana	88.31 c	346.00 a	11.222 a
Sariab-95	90.52 b	293.67 b	9.782 b
Rasco-2005	90.05 c	347.17 a	11.782 a
Tijaban-10	97.50 a	263.67 c	11.404 a
SE ±	1.5465	5.1566	0.3684
LSD 0.05	2.3491	10.834	0.7740
LSD 0.01	4.4515	14.843	1.0604

Table 2: Spikelets spike^{-1}, grains spike^{-1} and seed index of wheat varieties sown under soil and climatic conditions of Quetta (Balochistan)

Varieties	Spikelets spike^{-1}	grains spike^{-1}	seed index
Rakhshan-10	16.410 b	35.611 b	40.606 b
Zardana	16.431 b	37.166 b	42.456 b
Sariab-95	15.010 c	33.111 c	37.606 c
Rasco-2005	17.261 a	40.334 a	46.056 a
Tijaban-10	16.010 b	35.444 b	40.040 b
SE ±	0.4110	1.2155	2.0743
LSD 0.05	0.8635	2.5536	4.3579
LSD 0.01	1.1831	3.4986	5.9707

Table 3: Biological yield ha^{-1} and grain yield ha^{-1} of wheat varieties sown under soil and climatic conditions of Quetta (Balochistan)

Varieties	Biological yield ha^{-1}	Grain yield ha^{-1}
Rakhshan-10	12170 b	5025.60 b
Zardana	12881 a	5157.60 a
Sariab-95	11250 d	4271.20 d
Rasco-2005	12877 a	5357.60 a
Tijaban-10	11740 c	4553.20 c
SE ±	152.14	87.275
LSD 0.05	319.63	103.36
LSD 0.01	437.91	251.22

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