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PERFORMANCE OF HIGH YIELDING WHEAT AND BARLEY CULTIVARS UNDER MOISTURE STRESS

AMANULLAH[1*], SHITAB KHAN[1], SHAD KHAN KHALIL[1], AMANULLAH JAN[1], AMIR ZAMAN KHAN[1] AND KHALID NAWAB[2],

[1]Department of Agronomy, [2]Department of Agriculture Extension and Communication, Agricultural University Peshawar, Khyber Pakhtunkhwa, Pakistan
**E-mail: draman_agronomist@yahoo.com*

Abstract

The performance of six high yielding wheat (*Triticum aestivum* L.) and two barley (*Hordeum vulgare*) cultivars was studied under moisture stress. The experiment was undertaken at the Agricultural Research Farm of Agricultural University Peshawar, during winter 2003-04 on six wheat cultivars: BARS-II, Saleem-2000, Haider-2000, Kohat-2002, Suleman-96 and Takbeer and two barley cultivars: Sorab-96 and Awaran-2002. Sorab-96 produced the highest (296 m^{-2}) number of tillers while Haider-2000 and BARS-II each produced the lowest (185 m^{-2}) number of tillers. Plant height ranged between 77 (Sorab-96) to 117 cm (Sulaman-96). Takbeer produced the highest (73) number of grains $spike^{-1}$ in comparison with Awaran-2002 which produced only 45 grains $spike^{-1}$. The 1000-seed weight was highest (43.13 g) in Awaran-2002 and lowest in Kohat-2002 (23.21 g/1000-seeds). Saleem-2000 produced the highest grain yield (3875 kg ha^{-1}) as well as biological yield (8833 kg ha^{-1}). Both barely cultivars performed better, though Awaran-2002 displayed slightly superior results than Sorab-96. The harvest-index was maximum (53.7%) for Kohat-2002 and lowest for Sorab-96 (20.9%). The average grain yield of six wheat cultivars was higher than the average grain yield of the two barley cultivars. In this investigation, wheat cultivars: Saleem-2000, Haider-2000 and Kohat-2002, produced higher (3875, 3525, 3225 kg ha^{-1}) grain yields, respectively and are therefore, recommended for cultivation in dryland areas.

Introduction

The development of drought tolerant cultivars is of global interest due to an increasing population and decreasing water resources (Nguyen, 1999). Improved farm practices are important to achieve higher yields (Anon., 1989). Dryland agriculture is an important component of our national economy of which currently contributes around 15 billion rupees annually. About 12% of the total wheat production is harvested from rain-fed areas, which can be increased considerably with appropriate production technologies (Khan *et al.*, 2001). Wheat is a major staple food crop in Pakistan cultivated on 1033.3 thousand hectares un-irrigated land in Pakistan with 116.6 thousand tones production (Anon., 2003).

Barley is mostly used as animal feed in Pakistan grown in temperate regions of the world at high altitudes. It is tolerant to drought, frost and alkaline soil conditions. Barley is an important food crop among communities in dry marginal environments and a major staple food in some parts of North Africa and the Near East, the highlands of Central Asia, Horn of Africa, Andean countries and the Baltic States. Barley is also a model species for molecular and physiological purposes (Koornneef *et al.*, 1997) grown in environments ranging from the deserts of the Middle East to the high elevations of the Himalayas (Hayes *et al.*, 2003). It remains the most viable option in dry areas and in production systems where alternative food crops are limited. Differences in yield and yield components of different barley cultivars under water stress condition were reported by Barriga & Funtealba (1976), Khan & Bajwa (1990), Ciha (1983) & Gebeyuhu (1987). Grain yields vary among sites and growing seasons as a consequence of variation in distribution and amount of rainfall (Acevedo *et al*, 1991). Cultivated barley and its wild ancestors differ in some agronomic important traits, such as seminal root, floral structure, tolerance to salinity, grain size, protein content, earliness, production of biomass and grain, plant height in drought conditions and tolerance to drought (Baum *et al.,* 2003).

Previous research suggested that barley cultivars: Sanober and Awaran-2002 at the seed rate of 120 kg ha^{-1} gave maximum grain yield under moisture stress condition of Khyber Pakhtunkhwa, Pakistan (Amanullah *et al*., 2008). In another recent study, Amanullah *et al*., (2010) investigated the performance of five high yielding wheat cultivars: BARS-II-II, Azri-96, Haider-2000, Daman-98 and Suleman-96 under moisture stress conditions and found that cultivar Haider-2000 at seeding rates of 80 kg ha^{-1} produced maximum grain yield and net returns under moisture stress conditions of Khyber Pakhtunkhwa. The objective of the current research was to explore cultivars of wheat and barley which can withstand moisture stress conditions and produce higher grain yields.

Materials and Methods

The experiment was carried out at the Agricultural Research Farm of KP Agricultural University Peshawar during winter season 2003-04. The Research Farm is located at 34.01° N, 71.35° E, 350 m above sea level in Peshawar valley located about 1600 km north of the Arabian Sea and has continental type of climate. Soil is clay loam, low in organic matter (0.87%), phosphorus (6.57 mg kg^{-1}), potassium (121 mg kg^{-1}) and alkaline (pH 8.2) and is calcareous (Amanullah *et al.*, 2009).

A randomized completed block design (RCBD) design with 3 replications was used. The experimental plots were 1.8 m wide and 5 m long with 6 rows 30 cm apart. A uniform basal dose of 80 kg ha^{-1} nitrogen (urea) and 60 kg ha^{-1} P_2O_5 (single super phosphate) was applied and mixed with the soil during seedbed preparation. The field was irrigated one week before sowing. The plots were sown at field capacity, and then no irrigation was applied till harvesting. The cultivars: BARS-II, Saleem-

2000, Haider-2000, Kohat-2002, Suleman-96 and Takbeer were used for the wheat crop; while Sorab-96 and Awaran-2002 were used for the barley crop. The plot was well prepared prior to sowing and recommended agronomic crop production practices including weeding and spraying were performed during the course of the experiment. Data was recorded for plant height (cm), tillers, grains spike^{-1}, 1000-seed weight (g), harvest index (%) grain yield (kg ha^{-1}) and biological yield (kg ha^{-1}). Data were statistically analyzed (Steel *et al*., 1996) and means were compared between treatments using LSD at $p \leq 0.05$.

Results and Discussion

The number of tillers m^{-2} was not significantly affected under water stress conditions. Number of tillers per m^{-2} ranged from 296 (Sorab-96) to 182 (Haider-2000) Plant height was significantly affected by moisture stress and ranged from a minimum of 77 (BARS-II) to a maximum of 117 cm (Suleman-96). Similarly, the differences in grains spike^{-1} were significantly different under moisture stress. Highest (73) number of grains spike^{-1} were produced by Takbeer, followed by Suleman-96 (63), while the lowest were recorded for Sorab-96. Also 1000-grain weight was significantly affected by water stress and ranged from a minimum of 23.21 g (Kohat-2002) to a maximum of 43.13 g (Awaran-2002). Grain and biological yields as well as harvest index all differed significantly among different cultivars of wheat and barley. Grain yield was maximum for wheat cultivar Saleem-2000 (3875 kg ha^{-1}), followed by Haider-2000 (3525 kg ha^{-1}), while barley cultivar Sorab-96 produced the lowest (1267 kg ha^{-1}) grain yield. Biological yield was maximum for Saleem-2000 (8833 kg ha^{-1}), followed by Haider-2000 (7417 ha^{-1}), while BARS-II produced the lowest (4083 kg ha^{-1}) biological yield. The highest harvest index of 53.7% was calculated for Kohat-2002, followed by Haider-2000 (47.7%), while Sorab-97 exhibited the minimum (20.9%) harvest index (Table 1).

Table 1. Number of tillers m^{-2}, plant height, grains spike^{-1}, 1000-grains weight, biological and grain yield, and harvest index of high yielding wheat and barley cultivars under moisture stress.

Crop	Cultivars	Tillers m^{-2}	Plant height (cm)	Grains spike^{-1}	1000-grains weight (g)	Biological yield (kg ha^{-1})	Grain yield (kg ha^{-1})	Harvest index (%)
Wheat	BARS-II	185	95	52	38.12	4083	1892	45.3
	Saleem-2000	263	90	59	43.02	8833	3875	44.5
	Haider-2000	185	91	55	35.98	7413	3525	47.7
	Kohat-2002	214	88	53	23.21	6417	3225	53.7
	Suleman-96	266	117	63	27.23	5583	2308	38.3
	Takbeer	230	96	73	24.92	5917	1887	33.2
Average		**224**	**96**	**59**	**32**	**6374**	**2785**	**44**
Barley	Sorab-96	296	77	50	38.02	6500	1276	20.9
	Awaran-2002	273	86	45	43.13	6625	1450	23.3
Average		**285**	**82**	**48**	**41**	**6563**	**1363**	**22**
$LSD_{0.05}$		**ns**	**6**	**4**	**1.83**	**1808**	**975**	**18**

Our results are in accordance with earlier reports (Amanullah *et al*., 2008; Amanullah *et al*., 2010). We found in this experiment that except for number of tillers m^{-2}, grain yield and yield components were all significantly affected as a consequence of water deficit conditions in the soil; which resulted in lower grain yield and biological yield. In an experiment on six cultivars of wheat that roots, leaves and seedling height were all significantly affected by moisture stress (Boubaker & Yamada, 1995). Plant height, dry weights of roots/stem and chlorophyll contents in leaves, number of spikelets and seeds per spike differed significantly among wheat cultivars as subjected to water stress (Safaie & Ghadiri, 1995). Water stress at tillering, flowering or grain filling decreased grain yields by 9.06%, 17.73% and 10.96%, respectively, in wheat. Grain yield and harvest index in wheat were found to be the most reliable characters for selection under drought stress conditions (Sharma & Bhargava, 1996). Singh *et al*., (1997) exposed 10 wheat cultivars to water stress and found seed germination to be decreased with water stress. Cultivars with the high germination percentage produced high yields when grown in field under rain-fed conditions. The lower grain and biological yield recorded in our experiment were the result of negative impacts upon some of the vital contributing factors described here and corroborated by other researchers. In this work Saleem-2000 and Haider-2000 proved to be the high yielding cultivars. Saleem-2000 produced both the highest grain yield (3875 kg ha^{-1}) and biological yield (8833 kg ha^{-1}). Both barely cultivars performed better, though Awaran-2002 displayed better results. These cultivars are therefore recommended for cultivation in arid regions.

One of the objectives of our experiment was to compare wheat and barley under cultivars moisture stress conditions. The average values of tillers m^{-2} (285), 1000-grains weight (41) and biological yield (6563 kg ha^{-1}) were higher for barley cultivars than for wheat cultivars. On the other hand wheat produced taller plants (96 cm), more grains spike^{-2} (59), highest grain yield (2785 kg ha^{-1}) and harvest index (44%) than barley cultivars. Interestingly, in our work, wheat performed better than barley in producing more grain yield than barley under water deficit conditions. The higher grain yield in wheat was the result of the production of higher number of grains spike^{-1} in wheat compared to barley. On the other hand barley is primarily grown for its biological yield due to its feed value and so we attained higher biological yield for barley compared to wheat. The higher biological yield produced in barley was mainly the result of the production of higher number of tillers m^{-2} in barley than wheat. The differences in yield and yield components of wheat and barley cultivars might be due to the differences in their

genetic makeup, nutrient up take and adaptability to moisture stress conditions (Amanullah *et al*., 2008; Kamran *et al*., 2009; Amanullah *et al*., 2010; Tyagi *et al*., 2011; Xin *et al*., 2011).

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