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Evaluation of several novel bread wheat cultivars in Kerman province's warm regions

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ABSTRACT

Bread wheat cultivars Chamran, Chamran2, and Sirvan are the dominant cultivars in Kerman province's warm regions. Due to their obsolescence and lack of purity, farmers are dissatisfied with the performance of common cultivars. Therefore, if the new cultivars outperform the conventional cultivars in terms of yield, they should be used to replace the conventional cultivars. The quantitative yield of 12 bread wheat cultivars was determined quantitatively in this experiment using a randomized complete block design with three replications. At a 5% probability level, the combined analysis of variance revealed that the year effect was significant for 1000-seed weight, plant height, and spike length. Additionally, at a 5% probability level, there is a significant difference between cultivars in terms of grain yield, 1000-seed weight, plant height, and spike length, indicating a genetic difference between cultivars. Sarang cultivar produced the most grain (7191.33) kg/ha, while the Chamran cultivar produced the least grain (6376.50 kg/ha). Sarang cultivar averaged 46.6 grams per 1000 seeds, while Shush cultivar averaged 35.1 grams per 1000 seeds. The Mehregan, Sirvan, and Tirgan cultivars, on the other hand, had the longest spikes at 10.16, 10.06, and 10 cm, respectively, while the Chamran2 cultivar had the shortest spikes at an average of 7.46 cm. The Chamran cultivar reached a height of 104.16 cm, while the Chamran2 and Aflac cultivars reached 94.33 and 94.16 cm, respectively. According to the findings of this study, Sarang, Shush, Khalil, and Tirgan wheat cultivars should be used in place of older and conventional cultivars in warm areas of Kerman province, depending on available facilities.

Highlights

- This experiment used a randomized complete block design with three replications to quantify yield characteristics of 12 bread wheat cultivars.
- Grain yield, 1000-seed weight, plant height, and spike length differ significantly between cultivars, indicating genetic differences.
- The longest spikes were 10.16 cm for the Mehregan, Sirvan, and Tirgan cultivars, while the shortest spikes were 7.46 cm for the Chamran2 cultivar.
- Sarang, Shush, Khalil, and Tirgan should be used in place of older conventional cultivars in warm areas of Kerman province.

1. Introduction

Wheat (*Triticum aestivum*) is one of the most important grains in the world, which accounts for about 31% of total grain consumption in the world (Yousefi Moghadam et al., 2018). Iran ranked seventh in the world in terms of the high volume of wheat consumption. Increasing the production of this plant will help reduce food prices and the poverty ratio (Chen and Ravallion, 2007). According to the latest statistics in the country, wheat production is 14,592,003 tons of seeds per 5,928,728 ha, of which about 97% of the wheat is used for bread (Anonymous, 2018). The most important agronomic species of wheat include bread wheat (Triticum aestivum) and durum wheat (Triticum turgidum var. Durum). The durum species, which are divided into two growth groups based on growth type, account for only about 8% of the

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total area of wheat cultivation in the world. In areas where conditions are not suitable for producing bread wheat, the durum species are considered important crops (Srivastava, 1984; Fabriani and Lintas, 1988).

Considering the importance of wheat in the country and the importance of productivity more than the existing agronomic and environmental capabilities, modified and productive cultivars must be found to be replaced by the current cultivars. It is hoped that this method will allow the potential capabilities to be used. On the other hand, wheat is a strategic product and is considered the basic food of the country. In addition to the necessity for self-sufficiency in the production of this plant, the following issues are worth considering: increasing the need for more production of this product; the importance of increasing variation in existing cultivars in the country (which ultimately increases the power of production); the importance of replacing existing cultivars (due to the broken resistance of diseases, etc.). These items are necessary to achieve higher yields and adapt the findings of research to farm conditions (Esmaeilzadeh Moghaddam, 2013). In most international wheat research centers in the world, comparisons of performance and adaptation have been carried out to achieve new wheat cultivars and plan to transfer new findings to farmers. In Iran, for many years, such schemes have been carried out. The result of these studies has introduced new wheat cultivars, such as Chamran, Hamoon, Aflac, etc., into the country and the region. The implementation of research-promotion projects in the country has had very effective results in the introduction, development, and promotion of new cultivars (Esmaeilzadeh Moghaddam, 2013).

The first step in a genetic improvement program is the choice of parents. Success in plant breeding projects mainly depends on factors such as the ability to recognize parents, combining desirable traits through the hybrid, identification, and effective choice among the differentiating masses. Following that, the next goal is the high and sustainable performance of these programs (Baker, 2020; Knott, 1987; Stoskopf et al., 1993). In this regard, extensive experiments were performed to compare performance to determine the differences between specific lines and cultivars and their performance potential (Austin, 1982; Stoskopf et al., 1993; Yazdansepas, 1997). Studies conducted in the tropics on the comparison of yields of different cultivars showed that cultivars S-90-3, S-90-4, S-90-5, S-90-6, and S-90-7 in terms of yield and characteristics optimal crops are in better conditions than the dominant cultivar of the region (Chamran). Bread wheat of Sirvan cultivar with PRL / 2 * PASTOR pedigree with high yield, tolerant of late water shortage, and good bakery-quality in 2012, for planting in the conditions of moisture stress at the end of the season in temperate regions of the country was introduced. Sirvan wheat has a high grain weight of 1000 grains, very high tillering power, and suitable resistance to plant lodging is relatively early and adapted to warm to temperate climates. Due to the tolerance of this cultivar to yellow rust, it is a suitable alternative to the Chamran cultivar (Najafian et al., 2012).

The Mehregan cultivar is one of the second international treasures received from the Corn and Wheat Research Center (CIMMYT). This cultivar was evaluated in Karaj in the 2007-2008 crop year. This cultivar was studied in the adaptation test to the hot and dry climate of the south, which was carried out for two cropping years (2008-2009) in six stations in the hot and dry climate of the south of the country. The results showed that this cultivar had a stable grain yield in all the evaluated stations. High yield potential, relatively good tolerance to late-season heat, relative maturity, acceptable resistance to yellow, brown, and black rust diseases, and good bakery quality are important features of this cultivar (Esmaeilzadeh Moghaddam et al., 2017).To study the compatibility of Omidbakhsh wheat lines, 16 lines along with two commercial cultivars (Chamran and Aflac) were studied for two crop years (2012–2014) in six research stations (Zabol, Ahvaz, Darab, Dezful, Iranshahr, and Khorramabad). The results of the experiment showed that the lines S-91-6, S-91-13, and S-91-15 with average grain yields of 6262, 6251, and 6315 kg/ha, respectively, with average yield ranks (7.4, 7, and 6.5, respectively) and standard deviation had lower ranks (3.8, 3.84, and 3.48, respectively) and higher performance ratio index (104, 104, and 105, respectively) than the control. These lines were concurrent with the control in terms of processing time. They also had better general adaptability and, consequently, grain yield stability (Esmaeilzadeh Moghaddam, 2013).

The Parsi cultivar (line) M-84-17 was produced from the cross of the irrigated wheat lines "S-Buc" / "S-Dove", as the mother plant, and the Darab wheat cultivar, as the father plant, in Zarghan Agricultural Research Station, in the crop year 1994-95. It should be noted that the irrigated wheat line ""S-Buc" / "S-Dove" is one of the improved lines at the Center for International Corn and Wheat Research (CIMMYT). In the 1995-96 crop year, the F1 generation was crossed with the Darab cultivar again. Generation F1 with "S-Buc" / "S-Dove" / 2 * t Darab pedigree was evaluated and its seeds were selected as the superior generation for planting, evaluation, and selection in the F2 generation at the Zarghan station during the 1996-1997 crop year. Due to its high yield potential, resistance to yellow rust, and the race of Ug99 of black rust disease, as well as very good bakery-quality and good agronomic characteristics, this cultivar was recommended for planting in irrigated farms in Iran (Najafian et al., 2010). Bread wheat of Aflac cultivar (S-80-18) is a mid-maturity, medium-sized cultivar, with medium height, sensitive to grain fall and plant dormancy, suitable for early planting dates, and adapted to warm regions. The Aflac cultivar is one of the heat tolerant cultivars (Esmaeilzadeh Moghaddam, 2011).

To study the phenological traits of commercial bread wheat cultivars, an experiment was conducted in the 2015-2016 crop year in a randomized complete block design with three replications in experimental farm number one of the Department of Agriculture and Plant Breeding of Shahid Chamran University of Ahvaz. The treatments included ten commercial bread wheat cultivars,

namely Sistan, Dez, Chamran 2, Kavir, Roshan, Pishtaz, Mehregan, Shush, Verinak, and Chamran. The Mehregan cultivar, with 7680 kg/ha, had the highest yield among cultivars and showed a better yield than the control cultivar, Chamran (6346.7 kg/ha) (Mousavi et al., 2016). The contribution of each yield component in justifying grain yield can also be indirectly affected by other components (Mehmet and Tetal, 2006). The advantage of path analysis over correlation coefficients is that, through causal analysis, the indirect effect of each performance component can be separated from the direct effect of that particular component on performance. In fact, the interrelationship between components creates an indirect effect (Mehmet and Tetal, 2006). Plaut et al. (2004) also noted a negative relationship between 1000-seed weight and the number of seeds per spike.

Wheat is a major crop in the warm region, where it contributes significantly to food production. Due to the critical role of improved seeds in increasing yield and area under wheat cultivation in the region, which is the primary source of income for farmers, and the requirement for self-sufficiency in wheat production in accordance with national policies, new cultivars with higher yields and desirable agronomic properties should be reviewed on a continuous basis, and existing cultivars should be replaced. Thus, to achieve the desired cultivars, such schemes are necessary and critical. As a result, new cultivars or lines must be introduced to farmers in cases of superiority. Over 90% of the area under irrigated wheat cultivation in the Kerman Research Center's work area is located in warm areas. Around 500 hectares of land in this area are affected by salinity. It is critical to obtain and introduce more productive cultivars than cultivars in hot areas such as Vakilabad and Baft city. Utilizing existing wheat production potential effectively requires the use of appropriate cultivars.

2. Materials and methods

In this experiment, the yield and some agronomic characteristics of 12 bread wheat cultivars were determined, including the Chamran cultivar as a control, as well as Shush, Parsi, Sivand, Sirvan, Chamran 2, Aflak, Mehregan, Khalil, Sarang, Tirgan, and Talaei cultivars in the warm Vakilabad area of Kerman province's Baft city. They were calibrated using a four-replication randomized complete block design.

2.1. Experimental area

The Vakilabad hot region is located one hundred kilometers southwest of Baft county in Kerman, Iran. It is located at 25.0° and 65.6° east longitude and 29° and 28° north latitude. It is an average of 1150 meters above sea level. According to the Amberje climate classification, this region has a mild to warm desert climate. The county has mild and relatively humid winters and hot and dry summers. The average annual maximum temperature is 31.7 °C, the average annual minimum temperature is 15.49 °C, and the annual rainfall is 160 mm. Its absolute minimum temperature is -11.4 °C.

2.2. Experimental layout and treatments

The experiment was planted in the cropping years 2019-2020 and 2020-2021, and in both years in a field that was the fallow year. The number of seeds of each cultivar was determined based on 400 seeds per square meter and considering the weight of 1000 seeds. Each cultivar was planted manually in six six-meter rows with 20 cm line spacing. Therefore, the area of each experimental plot was 7.2 square meters, and a margin of one meter was considered between each replication. According to the experiments performed and according to the needs of the farm soil, the amount of fertilizer used was based on the recommendations of the colleagues of the Water and Soil Department (Table 1).

Table 1. Result of soil analysis of experimental site

Year	Soil texture	O.C. (%)	P ($mg.kg^{-1}$)	K ($mg.kg^{-1}$)	pH	EC ($dS.m^{-1}$)
2019	Loamy clay	0.48	10.2	198	7.9	2.8
2020	Loamy clay	0.51	11	219	7.8	2.6

All phosphorus and potash fertilizers, microelements, and one-third of the nitrogen fertilizer were applied simultaneously with planting. The rest of the nitrogen fertilizer was applied as Sarak (fertilizer to the soil after planting) at the appropriate time, which is usually between tillering and flowering stages. Field weeds were chemically controlled during the growing season based on the recommendations of plant protection colleagues. Irrigation was done according to the conventional method of the region, and after the physiological maturity of the cultivars, harvesting was done in each plot from the four middle lines and after removing half a meter from both sides of each line.

Necessary notes such as planting date, frost damage, plant height, cluster length, dormancy percentage, and yield were taken. Plant height at the time of physiological maturation of genotypes (fading of green from glume and glume) was obtained by measuring the height of 10 randomly selected stems from the soil surface to the end of the spike. Finally, simple and compound analyses of variance and mean comparison are performed by the Duncan method, and the best cultivars will be introduced for research-extension projects or recommendations to farmers and the province's agricultural management.

3. Results and discussion

3.1. Results of combined analysis of variance

The results of the combined analysis of variance are shown in Table 2, and the mean comparison of the studied traits during the two years of the experiment is given in Table 3. The results of the combined analysis of variance showed that the year effect was significant for 1000-seed weight, plant height, and spike length at a 5% probability level. Also, there is a significant difference among

cultivars in terms of grain yield, 1000-seed weight, plant height, and spike length at the 1% probability level, which indicates a genetic difference among cultivars. Among different treatments, the Sarang cultivar with a yield equal to 7191.33 kg/ha had the highest, and the Chamran cultivar with a yield equal to 6376.50 kg/ha had the lowest grain yield. Also, the Sarang cultivar with a weight of one thousand seeds had the highest weight of equal to 46.6 g, and the Shush cultivar with an average 1000 seed weight had a minimum weight of 35.1 g. The Chamran cultivar with 104.16 cm had the highest plant height, and the Chamran 2 and Aflak cultivars with 94.33 and 94.16 cm had the lowest plant height. Also, Sirvan, Mehregan, and Tirgan cultivars had the highest spike length, and the Chamran 2 cultivar had the lowest spike length among the tested cultivars (Table 3). Varga et al. (2001) also showed that there is a significant difference between different wheat cultivars in terms of grain yield.

Table 2. Combined analysis of variance results of studied traits

		Sum of squares			
S.O.V	**df**	**Grain yield**	**1000 seed weight**	**Plant height**	**Spike length**
Year	1	5.24	4.60 *	8.64 *	35.83 *
Error 1	4	1.76	1.37	0.58	2.10
Cultivar	11	37.17 **	27.07 **	32.52 **	16.38 **
Year×Cultivar	11	1.30	0.83	1.18	2.29 *
Error 2	44	1106.40	2.48	2.02	0.33
CV%	-	16.13	10.06	12.13	9.24

* and ** are significant at P=0.05 and P=0.01, respectively

Table 3. Comparison of two-year mean of studied traits for different cultivars

Cultivar	**Cultivar Number**	**Grain yield (Kg/ha)**	**1000 seed weight (g)**	**Plant height (cm)**	**Spike length (cm)**
Sivand	1	6499.83 f	38.8 de	97.66 c	9.25 bc
Sirvan	2	6955.67 cde	37.1 e	97.33 c	10.06 a
Tirgan	3	7064.67 bc	43.4 b	100.50 b	10 a
Aflak	4	6552.83 f	38.6 de	94.16 d	8.44 d
Khalil	5	7094.33 ab	40.5 cd	98.25 c	9.66 ab
Talaeei	6	6902 de	40.8 c	97.50 c	8.66 dc
Parsi	7	6842.17 e	41 c	98.66 c	8.25 d
Mehregan	8	6996 bcd	44.5 b	97.50 c	10.16 a
Shush	9	7107.33 ab	35.1 f	90.83 e	9.65 b
Chamran2	10	6870.67 e	43.8 b	94.33 d	7.46 f
Chamran	11	6359.83 g	43.5 b	104.16 a	8.36 de
Sarang	12	7191.33 a	46.6 a	97.50 c	7.93 f

Means in each column, followed by similar letter(s), are not significantly different at 5% probability level using LSD Test

The year-genotype interaction effect is given in Table 4 the year-genotype interaction effect was not significant for the measured traits. Although the Sarang cultivar in the second year with a yield equal to 7265.66 kg/ha had the highest yield, the Chamran cultivar in the second year with a yield equal to 6470 kg/ha had the lowest grain yield (Table 4). In terms of 1000-seed weight, the Sarang cultivar in the second year and the Shush cultivar in the first year, with 47 g and 36 g, respectively, had the highest and lowest 1000-seed weight. The highest and lowest plant heights were Chamran cultivars in the second year and Shush in the first year, with 104.66 cm and 90.66 cm, respectively. Mehregan and Tirgan cultivars with 10.83 cm in the second year had the highest spike height, and Chamran 2 cultivars with 7.43 cm had the lowest spike height in the second year (Table 4).

3.2. Correlation coefficients of the studied traits

The correlation coefficients for the traits examined are shown in Table 5. As can be seen, the weight of 1000 seeds has no discernible relationship with the spike's length. These findings corroborate the research of Plott et al. (2004). Additionally, there is a positive and statistically significant correlation between grain yield and 1000-grain weight at a 5% probability level (Table 5). In another study, the relationship between traits affecting wheat grain yield was investigated using Zarrin, Alvand cultivars, and promising lines on planting dates of 20 October, 10 November, and 30 November. The results indicated that grain yield with day to spike, day to maturity, plant height, number of spikes per square meter, and 1000-seed weight had a positive and significant correlation in both conditions of no stress and moisture stress. Using the aforementioned traits, path analysis revealed that the number of spikes per square meter and the day to maturity had the greatest direct and indirect effects on grain yield in both conditions (Mohammadi, 2014). On the other hand, there is a slight negative correlation between the weight of 1000 seeds and the length of the plant, as well as between the weight of 1000 seeds and the length of the spike. This correlation, however, is not statistically significant.

Table 4. Mean Comparison of studied traits under the influence of year interaction in cultivar

Year×Cultivar	Grain yield (ton/ha)	1000 seed weight (g)	Plant height (cm)	Spike length (cm)
Y1× V1	6444	38	97.66	8.33
Y1× V2	6913.33	36.66	97.66	9.66
Y1× V3	7006	43.06	100.33	9.16
Y1×V4	6403	38.33	92.33	8.06
Y1× V5	7110	40	97.50	9
Y1×V6	6864	40.33	97	8
Y1× V7	6813	41	97.66	8.33
Y1× V8	6977.33	42.93	96.33	9.50
Y1×V9	7098.33	36	90.66	9.50
Y1× V10	6916.66	44	94.66	7.50
Y1×V11	6283	42.66	103.66	8.40
Y1×V12	7117	46.33	97	8.63
Y2× V1	6555.66	39.66	97.66	10.16
Y2× V2	6998	37.66	97	10.66
Y2× V3	7123.33	43.83	100.66	10.83
Y2×V4	6702.66	39	96	8.80
Y2× V5	7078.66	41	99	10.33
Y2×V6	6940	41.33	98	9.33
Y2× V7	6871.33	41	99.66	8.16
Y2× V8	7014.66	46.06	98.66	10.83
Y2×V9	7116.33	34.33	91	9.80
Y2× V10	6824.66	43.66	94	7.43
Y2×V11	6470	44.33	104.66	8.33
Y2×V12	7265.66	47	98	8.73

Y1: First year, Y2: Second year, V1: Sivand, V2: Sirvan, V3: Tirgan, V4: Aflak, V5: Khalil, V6: Talaeei, V7: Parsi, V8: Mehregan, V9: Shush, V10: Chamran2, V11: Chamran, V12: Sarang

Table 5- Correlation coefficients between grain yield and some agronomic characteristics

Agronomic traits	Grain yield	1000 Grain weight	Plant height
1000 Grain weight	0.218*		
Plant height	-0.339	-0.301	
Spike length	0.011	-0.236	-0.209

* and ** are significant at P=0.05 and P=0.01, respectively

4. Conclusion

Chamran, Chamran 2, and Sirvan cultivars are the dominant cultivars of bread wheat in warm regions of Kerman province. Due to the obsolescence and lack of purity of common cultivars, farmers are not satisfied with the performance of these cultivars. Therefore, according to the results of this study, it is recommended that due to the stability of grain yield in Sarang, Shush, Khalil, and Tirgan cultivars in warm regions of Kerman province, and according to the existing facilities for seed production, Sarang, Shush, Khalil, and Tirgan should replace the old and conventional cultivars, respectively.

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