

Comparison of yield of 7 varieties of dry wheat in Sirvan city

Abstract

In this study, a comparison plan using seven dryland wheat cultivars adapted to the climate of this region including Aseman, Savarez, Zahab, Zagros, Chamran, Koohdasht, and Sirvan in the form of a randomized complete block design (RCBD) with three replications was conducted during the crop year 2019 - 20 to evaluate the yield of wheat cultivars and select a high yielding and suitable cultivar in the central region of Sirvan, Ilam. The highest grain yield belonged to the Savarez wheat cultivar with an average grain yield of 4590 kg/ha and the Chamran cultivar with a 3476 kg/ha yield had the lowest grain yield. Among the compared cultivars, Savarez and Zahab cultivars have a higher Thousand Kernel Weight (TKW) than other cultivars in the climatic conditions of this region. But in the Zahab cultivar, the final yield decreased due to the low number of spikes per square meter. The results also showed that the Savarez cultivar had a higher biological yield and harvest index in addition to grain yield. The results indicated that the number of grains per spike, TKW, biological yield, and harvest index was the most effective variables on grain yield and one of the most important agronomic traits for selecting wheat cultivars with high grain yield. Finally, considering the results, Savarez was found suitable among the studied cultivars due to its higher production capacity in the central region of Sirvan, and its cultivation in similar climatic regions is recommended.

Keywords: Dryland wheat, Yield, Yield components, Cultivar, Sirvan

**Zahra Sayadi^{1,*},
Heshmatollah Zarrin
Job², Behrooz Omid³,
Hossein Ali Hosseini⁴**

¹Master of Agriculture, Department of Agriculture, Dezful Branch, Islamic Azad University, Dezful, Iran.

²Dr. of Agriculture, Department of Agriculture, Varamin Khuzestan University of Agricultural Sciences and Natural Resources, Iran.

³Master of Agriculture, Department of Agriculture, Ilam University, Ilam, Iran.

⁴Master of Horticulture, Ornamental Plants, Department of Agriculture, Jiroft Branch, Islamic Azad University, Jiroft, Iran.

*Corresponding Author:
Zahrasayadi4@gmail.com.

Introduction

Wheat is one of the most important crops in terms of area under cultivation and production in the world and plays an important role in meeting the nutritional needs of human societies. Wheat is cultivated in the fall in Iran, except for a few areas. Under such conditions, the growing season of wheat coincides with fall and winter precipitation and the plant usually has no growth restrictions. In contrast, the reproductive and filling period of plants in late spring coincides with rising temperatures and water shortages, therefore plant growth is affected by heat and drought stresses and reduces production potential (Joudi et al., 2014). Common wheat¹ is the main crop that has a higher variety of cultivars due to high genetic diversity and adaptation to different environments (James et al., 1991). Wheat production is projected to increase by about 60% by 2050 compared to 2010 to meet global demand. A high share of this increase should be achieved by increasing grain yield per unit area. To achieve this goal by 2050, grain yield should increase by about 1.6% annually worldwide (Fao, 2016: 89). Wheat as one of the major agricultural products provides the most human food needs in different countries, especially in the third world. Many types of research have been done on the methods of increasing its product (Sarmadnia and Kouchaki, 1989). Developing the area under cultivation and increasing crop yield per unit area are two important strategies to increase the production of each plant. Grain yield is determined by its components (number of grains per spike, number of spikes per

unit area, and TKW) that have complex relationships with each other. To get the maximum grain yield, all its components must be at the desired level. That is why the analysis of the experimental results in terms of grain yield should consider these components and their interaction with each other (Sarmadnia and Kouchaki, 1989). A breeder will have a chance to succeed in breeding programs if he can choose the right materials and have enough variety. This diversity exists both naturally and artificially (Salehi Jozani et al., 2003). Breeders use genetic diversity to reach domesticated plants that meet their needs and ultimately increase production. Evaluation of genetic diversity in crops is of great importance for plant breeding programs and the protection of hereditary reserves (Farahani and Arzani, 2006). It means that no breeding program can be implemented without diversity because the existence of genetic diversity is necessary to select superior and appropriate genotypes (Abd Mishani and Bushehri, 1998). Given the current growth of the world's population and the serious shortage of food, especially in the tropics, the production of crops for nutrition is vital for the survival of humans and other living organisms so about 70% of the world's food comes directly from crops. Wheat is the most prominent crop in the world and has the largest area under cultivation (Yousefi Moghadam et al., 2018). Population growth around the world, especially in developing countries, has affected existing facilities to such an extent that the use of new cultivars with high yield potential is necessary to provide the food

¹ Also known as bread wheat

needed by this increased population (Ahmadi et al., 2017). To obtain maximum grain yield, the condition of its components must be optimal, therefore, it is necessary to carefully examine its components in the analysis of yield (Hosseini Pour et al., 2014). Wheat has always been considered one of the strategic crops in the development of different countries, so increasing its yield has always been considered by researchers (Iannucci et al., 2012). Grain yield in cereals is obtained from two main components of yield, i.e. the number of grains per unit area and the single grain weight (SGW). The number of grains is the most important component of grain yield in wheat the major part of changes in grain yield is determined by this component (Slafer et al., 1993). Donaldson et al., consider the number of fertile spikes per unit area to be the most important determinant of grain yield. The number of grains per unit area is the product of the number of spikes per unit area and the number of grains per spike. Planting time has a significant effect on wheat grain yield due to its effect on life length and in other words, the degree of growth day received by the plant and is one of the most important factors determining success in crop production (Hundal et al., 1997). Delay in planting wheat also reduces the vegetative growth period, reduces the number of leaves, and consequently reduces the total photosynthetic material for vegetative growth and the desired yield (Blye et al., 1990). Optimal growth of wheat and reaching the maximum quality and quantity of the crop requires a sufficient and balanced amount of low and high consumption elements in the soil. Therefore, the selection and application of fertilizer should be done according to the availability and fate of elements in the soil due to the interaction of elements with each other and the need for wheat for elements (Khajapour, 2006). Researchers have concluded that different cultivars, such as different

species, are adapted to certain climatic conditions, so cultivar selection is important for production success (Sun et al., 1991).

Materials and methods

This research was conducted in the 2019-20 crop year in the central part of Sirvan with geographical coordinates of 46 ° and north latitude and 33 ° and an altitude of 843 m above sea level. The experiment was carried out using 7 fall wheat cultivars (Aseman, Savarez, Zahab, Sirvan, Zagros, Koohdasht, and Chamran) in a randomized complete block design (RCBD). Each cultivar was planted in 10 lines of 50 m with a distance of ... cm from each other in plots with an area of 50 m². The field soil had a clay loam texture. The planting date was 2019.12.01 and the first precipitation was on 2019.12.02. The amount of grain used was 150 kg per hectare. The land was plowed by a chisel and a disk was used to crush the lumps and make the land uniform. The year before, the land was fallowed. The use of chemical fertilizers was based on soil tests. Grain sowing was done using a dryland deep grainer. In the tillering stage of growing, topic and granstar toxins were used to control narrow-leaved and broad-leaved grasses. Also, at the beginning of clustering, tilt was used due to the observation of wheat yellow rust. Decis was used due to observe the sunn pest. And harvesting was done in The most important traits measured in this study include grain yield, TKW, number of grains per spike, and plant height. Sampling was performed separately to determine grain yield. In this way, TKW, number of grains per spike, number of spikes per m² to determine the yield, and an area equal to 1 m² of the end and the intact part of each plot was harvested in the final stage and then weighed and counted all spikes and separating the spikes from the bushes, the grains were separated from the straw, and all grains were weighed and the TKW was measured.

Table 1: Precipitation (in mm) at the test site during the growing season

Month	Oct.	Nov.	Dec.	Jan.	Feb.	March	Apr.	May	
Rate of precipitation		7	42.5	133.5	29	54	211	3	0

Results and discussion

Shiranifar (1995) showed that the effect of cultivar and plant density on total yield, grain, straw, and harvest index was significant and the maximum wheat grain yield was obtained at a density of 400 plants per m². In general, less or more grains than usual reduces grain yield. Applying more grains than usual reduces the size of the grains and its lower grain rate reduces the number of spikes per unit area. Among the yield components, the number of spikes per m² and the number of grains per spike are more effective than grain weight in determining wheat grain yield (Schillinger et al., 2005; Donaldson et al., 2001). The number of spikes per unit area is the most important component in determining the grain yield

of wheat (Carr et al., 2003). Variation in the number of grains in Iranian wheat cultivars shows that this trait can change in the wheat breeding program. Several researchers believe that prolonging the grain filling course under heat stress conditions leads to high yields in wheat (Nourian et al., 2006)

Most researchers believe that a further increase in wheat yield is possible by increasing the number of grains per unit area, therefore the effect of the number of grains is greater than the effect of TKW in improving yield (Sades and Reference Serine, 2007). Grain weight per spike, number of grains per spike, and number of spikelets per spike are traits that affect TKW (Ahmadi et al., 2008). Most studies have found that the TKW has remained constant during the wheat breeding process

and has undergone fewer changes (Sades, 2007, Sanchez Garcia et al., 2012). The relationship between grain yield and grain filling length to physiological maturity is positive and significant which is consistent with the 2011 Fischer report. Previous studies by Brix, 1975 (Stasi, 2003) have also shown an increase in plant height due to increased grain rate. Due to the positive significant correlation between biological yield and straw yield, the number of spikes per unit area, and grain yield, it seems that increasing plant height to the desired level increases the formation of new and young leaves in vegetation and has granted it high photosynthetic efficiency. This has led to increased biological yield at high densities. This increase is mainly dedicated to non-reproductive components. Significant

differences between wheat genotypes with different heights and tillering were effective in producing biological yield (Donaldson et al., 2001). The amount of precipitation during the crop season in 2019-20 was equal to mm. Precipitation was not favorable in terms of distribution. So that the continuation of their decline from April onwards caused it to affect the yield, etc. Cultivars also differed in terms of the number of grains per spike. Koohdasht cultivar had the highest number of grains per spike and Chamran and Zagros cultivars had the lowest number of grains per spike. Among the cultivars, Aseman had the highest and Chamran had the lowest height.

Table 2: Comparison of the mean of some studied traits in seven different wheat cultivars

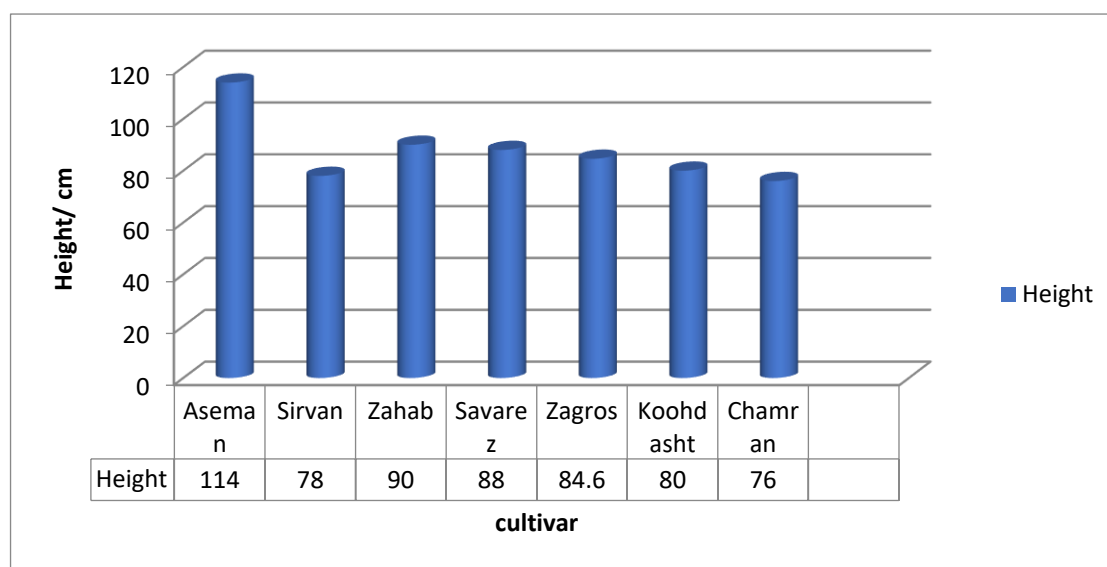
Cultivar	Number of spikes per m ²	TKW	Number of grains per spike	Plant height
Aseman	195	40	45	114
Sirvan	260	35	39	78
Zahab	177	45	54	90
Savarez	204	45	50	88
Zagros	231	38	43	84.6
Koohdasht	195	35	57	80
Chamran	231	35	43	76

Plant height

Plant height is the distance between the ground level and the end of the spike in the main stem without calculating the length of the awn. In each plot, 10 plants were randomly measured by observing the margin of the fields and the mean data were calculated and the main height was obtained. This trait was measured during the grain-filling period. The results showed

that the highest height was related to Aseman and the lowest to Chamran cultivar, and there was a significant difference between cultivars in terms of height (Figure 1).

The results of most studies have shown that the occurrence of water stress before flowering reduces plant height. Maximum plant height at the field level is higher due to more growth space and as a result more plant use of ecological conditions.



These results are consistent with Salemi and Afiuni's report (2005).

Figure 1. Comparison of the height of different wheat cultivars

Number of grains per spike

To measure this trait, 5 plants per plot were randomly selected and after threshing the spikes and counting the number of grains, the mean number of grains per 5 plants per plot was calculated. The highest grain yield was obtained for the Koohdasht cultivar and the lowest for Zagros and Chamran (Figure 2). One of the reasons for not reducing the number of grains per spike under stress conditions in resistant genotypes

is that in genotypes with higher osmotic ability, pollen grains remain swollen in drought stress conditions, and the effect of drought stress on the plant is reduced because the osmotic regulation is fully established in them, but in cultivars that cannot regulate osmosis, the pollen shrinks due to drought stress and inoculation rate decreases, as a result, yield components, including the number of grains per spike and TKW, and thus grain yield decreases (Riaz and Chowdhry, 2003).

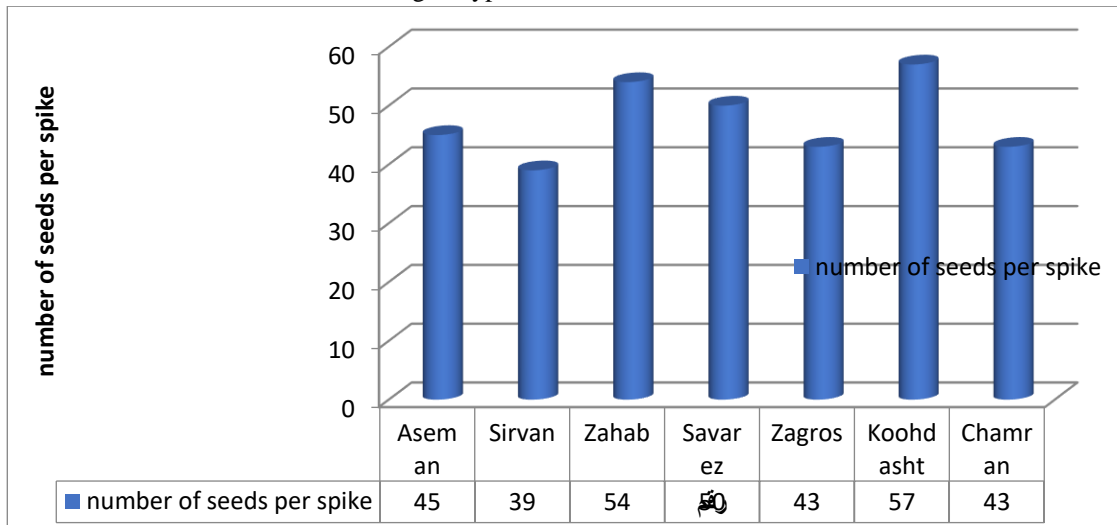


Figure 2. Bar chart of the number of grains per spike

Thousand Kernel Weight (TKW)

TKW is another important component of grain yield and is a characteristic of a variety that is strongly influenced by genetic factors, but its amount is also affected by the conditions of the ripening period (Kouchaki and Banayan Avval, 1373). A comparison of mean data shows that Savarez and Zahab cultivars have the highest TKW and Chamran and Sirvan have the lowest TKW. It is a genetic trait that is affected by environmental conditions and the length of the grain-filling period (Guarda et al., 2004). Studies have shown that one of the possible reasons for TKW loss is the delay in wheat planting, which is due to the reduction of photosynthetic resources and exposure of the plant to the pollination stage with high temperatures during the grain-filling period

(Anderson and Smith, 1990). To measure this trait, grain harvested in each plot was sampled and grains were counted manually and weighed with a scale of 0.01 g. It should be noted that the moisture content of the grains when weighing was 12-13%. The data obtained from TKW showed the difference between the cultivars tested in this study (Figure 3). Comparing the mean of the data shows that among the cultivars, Savarez and Zahab have a higher TKW (Figure 4). The reason for the TKW increase can be because photosynthetic material is transferred to the roots when the plant is growing vigorously. In root development, conditions are provided for nutrient uptake, which in turn increases photosynthesis. As the plant approaches maturity, it transports photosynthetic material to the reproductive organs.

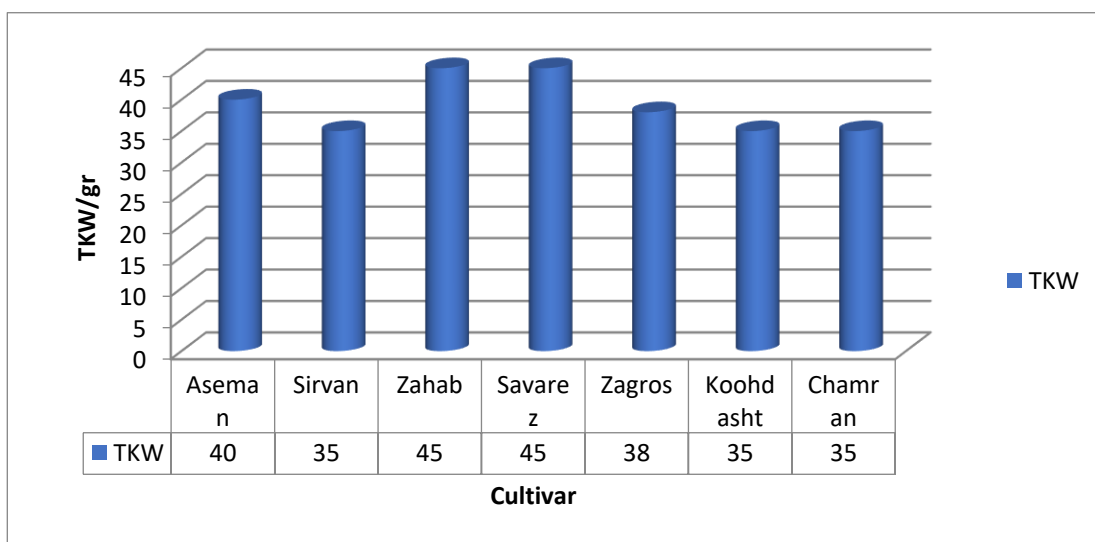


Figure 3. Bar chart of TKW per gram

Number of spikes per m²

The number of spikes per unit area is a trait determined by the number of fertile tillers. Because tillering is done during the winter (Majidi et al., 2018). Therefore, the role of winter tillers in improving yield is higher than spring tillers. In an experiment, it was reported that the number of fertile spikes

per unit area was the most important determinant of yield (Donaldson et al., 2001). Comparing the mean of the data showed that Sirvan, Savarez, Chamran, and Zagros cultivars have significant differences from other cultivars in terms of several spikes per m² (Figure 4).

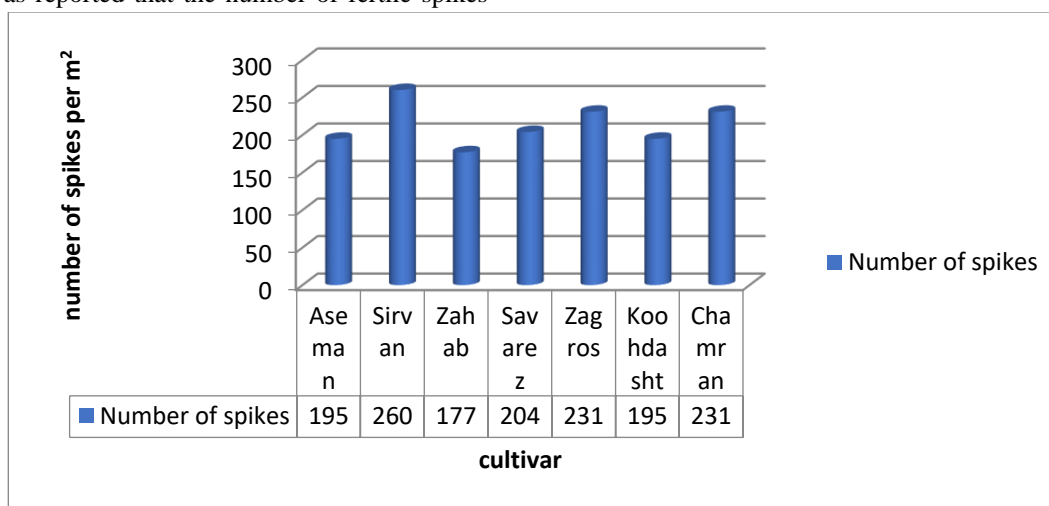


Figure 4. Bar chart of the number of spikes per m²

Grain yield

In a study, researchers reported that increasing the number of grains in pods partly justifies the increase in grain yield because more grains create a high demand for photosynthetic material and thus increase the production of photosynthetic material, and any factor that increases this parameter will lead to an increase in grain yield (Major et al., 1978). Nourian et al., in a study, showed that based on the results of path analysis, the number of pods per plant, number of grains per pod, growth period, and TKW were the most effective traits on yield. The most direct positive effect among the above traits belonged to the number of pods per plant and the lowest to the number of grains per pod (Nourian et al., 2006). Although there was a positive relationship between yield and some of its

components, the existence of negative correlations among some of these components has made the selection of all of them not to be useful in increasing grain yield (Rharr et al., 1998). An increase in one yield component usually leads to a decrease in some other components (Donaldson et al., 2001; Pollman et al., 1995). Therefore, determining the correlation between different traits, especially grain yield and its components, and determining the cause and effect relationships enables breeders to select the most appropriate combination of components that leads to higher yield (Duffing and Kenigs, 1992; Nachit et al., 1991). In this regard, the method of correlation analysis is of special importance (Subani and Chaudhry, 2000). This method clarifies the relationships between traits and their direct and indirect effects on each other. In this method, the correlation

coefficient between the two traits is separated into the components that measure these effects. Examining and determining the relationships of yield components is effective in recognizing different aspects of production, in a way that estimating grain yield is possible by using the initial estimate of the number of spikes per unit area and then the number of grains per spike and TKW (James and Roger, 1991). The correlation between grain yield and the number of spikes per unit area, harvest index, biological yield, and straw yield was positive and very significant and was negative and significant with TKW and the awn length. Also, the number of spikes per unit area and harvest index had the most direct and positive effect on grain yield (Derikvand and Hosseinpour, 2007). Grain yield in wheat is due to the cumulative effects of its constituent components. These components are affected by management practices, genotype, and environment-genotype interaction. Therefore, identifying these components and relationships with grain yield can be effective in selecting high-yielding varieties. A simple comparison table of cultivars shows that there is a significant difference between cultivars in

terms of grain yield so the Savarez cultivar with an average of ... kg/ha has the highest yield and Chamran with an average of ... kg/ha has the lowest yield (Figure 5). Therefore, comparing the mean data, it can be concluded that there is a positive significant relationship between TKW and the number of grains per spike with the final yield, and the improvement of grain yield is obtained as a result of these two important traits. It seems that cultivars with higher biological yield have been able to use photosynthetic sources more appropriately by using favorable environmental conditions and by producing more foliage, thus providing the ground for increasing grain yield. Correlation between grain yield and biological yield is also raised in previous research (Hosseinpour and Derikvand, 2007, Moghadam et al., 1997) Grain yield depends on its components, i.e. number of pods per plant, number of grains per pod, and TKW. The highest yield is achieved when the product of these parameters has the maximum value. The ability to compensate for yield components due to in-plant competition for food and metabolism prevents severe performance changes.

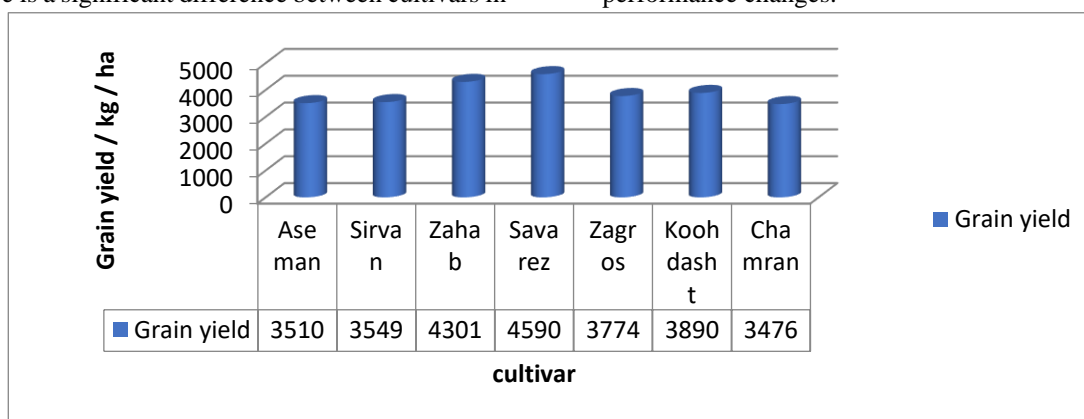


Figure 5. Bar chart of grain yield per kg/ha

Conclusion:

Investigation of genetic diversity and correlation of agronomic traits in 8 common wheat genotypes collected from southeastern Iran showed that grain yield had a positive significant correlation with spike length, the number of grains per spike, TKW, biological yield, and harvest index. But its correlation with the number of tillers per plant and the number of fertile tillers was negative and significant. Correlation analysis showed that the minimum direct positive effect on grain yield was related to plant height and harvest index, respectively. The maximum positive direct effect was related to TKW, the number of grains per spike, and the number of fertile tillers, respectively. The results of this study also indicated that the selection of superior genotypes in terms of grain yield should be based on the traits of the number of fertile tillers per plant, the number of grains per spike, and grain weight (Moghadam et al., 1997). The study of some agronomic

traits in common wheat showed that the correlation of harvest index with grain yield and biological yield was positive and significant. However, the correlation between plant height and harvest index, and grain yield was negative and significant and the number of tillers per plant and spike length was positive and significant with biological yield (Ahmad et al., 2003). According to the main objectives of crop programs that increase production, considering that the grain yield in the Savarez cultivar was relatively better, in case the water resources do not meet the water needs of the plant at the end of the season, this cultivar seems more suitable than other cultivars for cultivation in similar conditions of this study. Also, the study of traits showed that the improvement of grain yield could be due to the increase in grain yield components, including the number of grains per spike, TKW, etc. The results obtained from the correlation between grain yield and the number of spikes per unit area were consistent with the results of Ahmad et al., (2003). But it was inconsistent with the

results of Moghadam et al., (1997) and Hosseinpour et al., (2003). Although there was a positive relationship between yield and some of its components, the existence of a negative correlation between some components of yield had caused the selection of all of them not to be considered a useful factor in increasing grain yield (Rarrabeti et al., 1998). Because the significance of a simple correlation among traits cannot be a sufficient reason for the existence of cause and effect phenomenon, therefore, grain yield was studied as a dependent variable and other traits as independent variables to determine the direct and indirect effects. Accordingly, ineffective adjectives were removed and three traits i.e. number of spikes per square meter, the number of grains per spike, and TKW were determined as the most effective traits on grain yield (Table 2). Because the number of spikes per m² and number of grains per spike had a direct positive effect on grain yield, they could be considered effective criteria in selecting cultivars. Investigating and determining the relationships of yield components was effective in recognizing different aspects of production so that estimating grain yield was possible by first estimating the number of spikes per unit area and then the number of grains per spike and TKW (Jasemi and Roger, 1991). Given the above, although the number of spikes per unit area and the number of grains per spike had a significant positive and direct effect on grain yield, this probably did not mean that these two traits in all conditions could have a positive correlation with the high yield. Because the role of the interaction between these traits and other traits in determining the differences in the final product was more than the effect of each trait separately. However, identifying traits that are more common despite the diversity, not only from the point of view of genetic structure but also for understanding their role in achieving optimal yield can be effective in selecting cultivars (Hosseinpour, Ahmadi, Mohammadi, Derikvand 2014)

Interestsconflict of:

The authors declare that they have no conflict of interest

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Research suggestions:

In the present research project, it was observed that Savarez has a higher production among the studied cultivars, which is recommended for the climatic conditions of the drylands of the central part of Sirvan.

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References

1. Asadnejad, M., Farzaneh, M., Meskarbashi, M. 2017. Effect of planting date on yield and grain yield components of three wheat cultivars in competition with wild oats. *Scientific Journal of Agriculture*, Vol. 40, No. 1
2. Cerlak, e. A,f, m. 2020. Investigation of the effects of planting delay on yield and grain yield components of wheat cultivars. *Iranian Journal of Agriculture and Centers of Iranian Plants*. Volume 16. Number 2..
3. Taramesheloo, Ramin. New issues and topics of agriculture. Introduction of wheat cultivars. December 2011
4. <http://www.crop20.blogfa.com/post>
5. Hosseinpour, T., Ahmadi, A., Mohammadi, F., Derikvand, R. 2014. The effect of different amounts of grains on yield and yield components of wheat cultivars in dryland conditions. *Journal of Agriculture* No. 105
6. Hosseinpour, T., Mamghani, R. Siadat, S.A. and Bahari, M. 2003. Path analysis of agronomic traits for grain and straw yield of wheat genotypes under low irrigation conditions. *Journal of Agricultural Science*, 26: 1: 105-109
7. Derikvand, R. and Hosseinpour, T. 2007. Path analysis in different genotypes of bare barley under dryland conditions. *Proceedings of the Conference on Technology Sustainability Management, Production, Supply and Consumption of Agricultural Inputs, Conference Secretariat Publications*, p. 43
8. Khajapour,m,r.2006. Principles and basics of agriculture. Academic Jihad of Isfahan Industrial Unit.
9. Sarmadnia Q. and Kouchaki, A. 1989. *Physiology of Crop Plants (Translation)*. Mashhad University Jihad, 467 pages.
10. Shahrashbi, S., Imam, Yahya, Pirasteh Anousheh, H. 2015. Effect of drought stress and nitrogen fertilizer on grain yield and crop yield of wheat nitrogen in Sirvan cultivar in Fars province. *Iranian Journal of Crop Sciences*, Vol. 17, No. 4
11. Shahrashbi, S., Imam, Yahya, Pirasteh Anousheh, H. 2019. The effect of nitrogen levels on morphological traits and wheat grain yield under different irrigation conditions. *Journal of Plant Echo Physiology*, 11th Year
12. Shiranifar, B. 1995. The effect of different plant densities on tillering process and its relationship with yield in three wheat cultivars in Ahvaz climate. Master Thesis, Shahid Chamran University of Ahvaz, 117 pages
13. Saleh Ravan, M., Galeshi, S., Zeinali, A., Mohammadi, R., Rahemi Karizaki, A. 2016. Investigation of the effect of genotype and planting time on yield and yield components of wheat in dryland conditions. *Journal of Applied Plant Ecophysiology Research*, Vol. 3, No. 1.
14. Salehi Jozani, Gh. R. S. Abd Mishani, A. H. Hosseinzadeh., B. A. Seyyed Tabatabaei 2003. Investigation of genetic diversity in some commercial potato cultivars in Iran using RAPD-PCR technique. *Iranian Journal of Agricultural Sciences*. Vol. 34. No. 4
15. Abd Mishani, S., and Shah Nejat Bushehri, A. 1998. *Supplementary plant breeding*. 1st Ed. Vol. 1, Tehran University Press, p. 274
16. Attarbashi, M., Galeshi, S., Soltani, A., Zeinali, A. 2002. Relationship between phenology and physiological traits with wheat grain yield in dryland conditions. *Iranian Journal of Agricultural Sciences*, Vol. 33, No. 1
17. Farahani, A., A. Arzani. 2006. Genetic diversity of cultivars and F₁ hybrids of durum wheat using agronomic and morphological traits. *Journal of Agricultural Science and Technology and Natural Resources*. 10th year. No. 4 (b)
18. Ghodrati, Gh. 2012. Investigating the relationships between yield and its components in promising soybean lines. *Journal of Crop Physiology, Islamic Azad University, Ahvaz Branch*, 4th year, 15th issue
19. Kouchaki, A. and Khalqani, J. 1995. *Understanding the basics of crop production (ecophysiological attitude) (translation)*. Ferdowsi University of Mashhad Publications .536 pages.
20. Majidi, M., Faridi Separi, M., Saleh Ahmadi, M., Nasrollah Beigi, M.2018. Investigation of yield and yield components of new dryland

- wheat cultivars in comparison with Sardari cultivar. *Journal of Wheat Research*, Vol. 1, No. 1
21. Nabati, A., Sharifi, P. 2016. Yield and yield components of three wheat genotypes under irrigation regimes. *Journal of Ecophysiological Research of Crops*, Vol. 10, No. 1
 22. Nasr Esfahani, M., Rafizadeh, Sh., Rostampour, M., Karimkhah, M., Atash Bahar, S. 2013. Investigation of yield components of promising wheat lines in Isfahan. *Journal of Crop Physiology*, Islamic Azad University, Ahvaz Branch, 5th year, No. 17
 23. Nadyanfar, m. hidarigharaei, e. 2021. Investigating the effects of drought on the yield of irrigated and rainfed wheat in Bojnord region. *Agricultural science research in dry areas*. Period 3. Number 1.
 24. Nourian, M., Valizadeh, M., Alizadeh, B., Behmaram, R., 2006. Investigation of the relationship between yield and agronomic traits of 49 cultivars and ripe grainline (*Brassica napus* L.) in Golestan province, 10th Congress of Agricultural Sciences and Iranian Plant Breeding, Vol. 1, p.173
 25. Yousefi Moghadam, R., Khorram Del, S., Banayan Avval, M., Nasiri Mahallati, M. 2018. Comparison of old and new dryland wheat cultivars in response to planting date. *Journal of Agricultural Applied Research* Vol. 31, No. 2
 26. Ahmed, H.M., B.M. Khan, S. Khan, N.S. Kissana, and S. Laghari. 2003. Path coefficient analysis in common wheat. *Asian Journal of Plant Science* 2:6: 491- 494.
 27. Anderson, W.K. and Smith, W.R. 1990. Yield advantage of two semi-dwarf compared with two tall wheat depend on sowing time. *Australian Journal of Agricultural Research*, 41: 811-826.
 28. Blye E.N., Mason S.E., Sander D.H. 1990. Influence of planting date, seeding rate on wheat yield. *Agronomy Journal*, 22: 762-768.
 29. Brriigs, K.G. 1975. Effects of grainning rate and row spacing on agronomic characteristics of Glenlea, Pitic 62, and New Pawa wheat. *Canadian Journal of Plant Science* 55:363-367.
 30. Carr, P. M., R.D. Horsley, and W.W. Poland. 2003. Tillage and grainning rate effects on wheat cultivars. II. Yield components. *Crop. Science* 43: 210-218.
 31. Donaldson, E., W.E. Schillinger, and S.M. Dofing. 2001. Straw production and grain yield relationships in winter wheat. *Crop Science* 41:100-106.
 32. Donaldson, E., W.E. Schillinger, and S.M. Dofing. 2001. Straw production and grain yield relationships in winter wheat. *Crop Science* 41:100-106
 33. FAO, (2012 & 2016), FAO Statistical Databases. <http://faostat.fao.org>, 45 -67 & 89.
 34. Guarda, G., Padovan, S., and Delogu, G. 2004. Grain yield, nitrogen-use efficiency and baking quality of old and modern Italian bread- wheat cultivars grown at different nitrogen levels. *European Journal of Agronomy*, 21: 181-192.
 35. Hundal S.S., Singh R., Dhaliwal L.K. 1997. Agro-climatic indices for predicting phenology of wheat (*Triticum aestivum* L.) in Punjab. *Journal of Agriculture Science*, 67: 265-68.
 36. James, R.C. and J.V. Roger. 1991. *Wheat health management*, APS Press the American phytopathological experimentation design and analysis, John Wiley and Sons
 37. Joudi, M., Ahmadi, A., Mohammadi, V., Abbasi, A. and Mohammadi, H. 2014. Genetic changes in agronomic and phenologic traits of Iranian wheat cultivars grown in different environmental conditions. *Euphytica* 196: 237-249
 38. Major, D.J., J.B. Bole and W.A. Charnetski. 1978. Distribution of photosynthates after CO₂ assimilation by stem, leaves, and pods of rape plant. *Can. J. Plant. Sci.* 28:783-787
 39. Moghaddam, M., B. Ehdaie, and J.D.G. Waines. 1997. Genetic variation and interrelationships of agronomic characters in landraces of common wheat from southern Iran. *Euphytica* 95: 361- 369
 40. Nachit, M.M., H. Ketata, and E. Acevedo. 1991. Selection of morpho-physiological traits for multiple abiotic stresses resistance in durum wheat (*Triticum turgidum* L. Var. Durum). In pages 392-400, *Physiology-Breeding of Winter Cereals for Stressed Mediterranean Environments*. Montpellier, 3-6 July 1989
 41. Pohlman, J.M. and D. A. Sleper. 1995. *Breeding field crops*, (fourth edition). Henry Holt Publisher, New York
 42. Iannucci, A., Fragasso, M., Platani, C., Narducci, A., Miullo, V., and Papa, R. (2012). Dynamics of release of allelochemical compound from roots of wild oat (*Avena fatua* L.). *Agrochimica*, 3: 192-185
 43. Rharrabi, Y., S. Elhani, V. Martos Nunes, and L.F. Garcia Del Moral. 1998. Relationship between some quality traits and yield of durum wheat under southern Spain conditions. *CIHEAM-Option Mediterraneans*. 40: 529- 531
 44. Riaz, R., and M.A. Chowdhry. 2003. Genetic analysis of some economic traits of wheat under drought condition. *Australian Journal of Plant Science*. 2(10): 790-796.
 45. Slafer G.A., Andrad F.H. 1993. Physiological attributes related to the generation of grain yield in bread wheat cultivars released at different ears. *Field Crops Ressource*, 31: 351-367.
 46. Schillinger, W., D. Wellsandt, H. Schafer, S. Schofstoll, and R. Papendick. 2005. Tillage Method and Sowing Rate Relation for Dryland spring wheat, barley, and Oat. *PNW Handbook Series* 30: 2: 1- 13
 47. Stacey, T. 2003. *Wheat Crop establishment: grainning rate and depth and row spacing*. Canada Grain Council Complete Guide to wheat Management.
 48. Stougaard, R.N. and Q.W. Xue. 2004. Spring wheat grain size and grainning rate effects on yield loss due to wild oat (*Avena fatua*) interference. *Weed Science* 52: 133- 141
 49. Subhani, G.M. and M.A. Chowdhry. 2000. Correlation and path coefficient analysis in common wheat under drought stress and normal conditions. *Pakistan Journal of Biological Science* 3: 72-77
 50. Sun, W.C., Q.Y. Pan, X. Ann and Y.P. Yang. 1991. Brassica related oil grain crops in Gansu, China. In: *Mcgorogor, D. I. (ed.) Proceedings of the Eighth International Rapegrain congress*, Saskatoon, Canola. Pp. 1130-1135