ISPEC Tarım Bilimleri Dergisi, 7(4):718-729, 2023
ISPEC Journal of Agricultural Sciences, 7(4):718-729, 2023
DOI: https://doi.org/10.5281/zenodo.10207705

Evaluation of Some Oat Cultivars for Grain Yield, Yield Components and Quality Traits in Düzce Ecological Conditions

Hüseyin GÜNGÖR[1*], Mehmet Fatih ÇAKIR[2], Berkay Hakkı KANTAR[1], Bahar GEDİK[1] Ziya DUMLUPINAR[3]
[1]Düzce University, Faculty of Agriculture, Department of Field Crops, Düzce
[2]Düzce University, Environment and Health Coordination, Düzce
[3]Kahramanmaraş Sütçü İmam University, Faculty of Agriculture, Department of Agricultural Biotechnology, Kahramanmaraş
[*]Corresponding author: hgungor78@hotmail.com

Abstract
This study was conducted to determine the grain yield, yield components and quality characteristics of 15 oat cultivars in Düzce province in the 2021-2022 growing season. The experiment was established in a randomized complete block design with three replications. In this study, oat cultivars were examined panicle length, grain number per panicle, grain weight per panicle, thousand kernel weight, test weight, groat percentage and grain yield. According to the results, the average panicle length ranged from 13.23 to 20.83 cm, grain number per panicle ranged from 37.83 to 86.83, grain weight per panicle ranged from 0.96 to 2.75 g, thousand kernel weight ranged from 19.86 to 42.36 g, test weight ranged from 43.45 to 60.08 kg hl^{-1}, groat percentage ranged from 74.2% to 100.0%, and grain yield varied between 201.4 and 414.8 kg da^{-1}. According to the biplot graph, the analysis indicated that grain yield had a positive relationship with panicle length, grain number per panicle, and grain weight per panicle, while having a negative relationship with test weight and groat percentage. Correlation analysis revealed a positive relationship between grain yield and the number of grains per panicle, grain number per panicle, grain weight per panicle, thousand kernel weight, and test weight, while it had a negative relationship with groat percentage and panicle length.

Research Article

Article History
Received :12.06.2023
Accepted :20.07.2023

Keywords
Oat
yield
biplot graph
correlation analysis

1. Introduction

Oat is an annual, self-pollinated, important grain and forage plant belonging to the Gramineae family (Valentine et al., 2011). Oat are widely used in animal nutrition, and their importance in the pharmaceutical, cosmetic, and food industries continues to increase (Buerstmayr et al., 2007; Marshall et al., 2013; Şahin et al., 2017).

Oat have a special place and importance in human nutrition due to the proteins, unsaturated fatty acids, vitamins, soluble fibers, phytochemicals and minerals in the grain structure (Flander et al., 2010; Finnan et al., 2019).

In Turkey, in the year 2022, the oat cultivation area was 137.655 ha, the production quantity was 365.000 tons, and the average yield was 266 kg da^{-1} (TUİK, 2023).

The aim breeding studies is to develop short-stemmed, lodging-resistant, large-grained varieties of oats with a low husk percentage, high protein content, disease resistance, and high yield. Breeding studies for oats place a strong emphasis on quality, with different quality standards for oats depending on whether they will be used for human or animal nutrition. Oats with high protein, dietary fiber, and beta-glucan content and low fat and husk content are recommended for human consumption. In contrast, varieties with a high amount of protein and fat, and beta-glucan, low husk are preferred for animal feed (Sarı et al., 2012; Sabandüzen and Akçura, 2017).

Changing environmental conditions and cultivation techniques are influential in the effective selection of varieties with both high quality and a high grain yield. In breeding studies, the focus is on creating stable varieties with high yield and quality that are least susceptiple to the adverse effects of environment factors, suitable for regional conditions and cultivation methods. It is crucial to create varieties with high yield and superior quality now that the value of oats human nutrition has come to light. In oat cultivation, oat varieties with high yield and quality nutritional value that will adapt to the region are needed (Sarı and İmamoğlu, 2011; Şahin at al., 2019; Uzun and Halil, 2019; Mut et al., 2021).

Many researchers have reported that the relationship between grain yield and quality characteristics is important in oat breeding studies (Dumlupınar et al., 2011; Kapoor et al., 2011; Dumlupınar et al., 2017; Şahin et al., 2019). Correlation analysis measures the mutual relationship between different traits, helps determine appropriate selection criteria that provide improvements in yield and quality, and is used by plant breeders in variety development studies (Marjanovic-Jeromela et al., 2007; Dumlupınar et al., 2017).

Biplot analysis is a two-way table design that graphically represents row and column factors that allows for the analysis of two-way data between genotypes and traits. In recent years, the biplot analysis method, which can give the relationship between genotypes and traits as a whole, has provided advantages to researchers in choosing genotypes (Yan and Kang, 2003; Yan and Tinker, 2006).

This study was carried out to determine the yield and some quality characteristics of registered oat cultivars in Düzce ecological conditions, to determine the effects of the examined characteristics on grain yield by correlation analysis, and to determine the relationships between the examined characteristics and cultivars by the biplot analysis method.

2. Material and Methods

This study was conducted at Düzce location during the 2021-2022 growing season, following a randomized complete block design with three replications.

In the study, 15 oat cultivars were used as materials. The oat cultivars used in the experiment, along with the registering institutions and registration years, are presented in Table 1.

Table 1. The oat cultivars used in the experiment, owner company/institute and registration years

No	Cultivar	Owner Institutes/Companies	Registration Year
1	Diriliş	BDIARI	2017
2	Faikbey	BDIARI	2004
3	Fetih	AARI	2014
4	Halkalı	TARI	2020
5	Kahraman	TARI	2014
6	Katmerli	BDIARI	2020
7	Kazan	BDIARI	2020
8	Kehlibar	SM	2018
9	Kırklar	TARI	2014
10	Küçükyayla	TARI	2018
11	Otağ	BDIARI	2020
12	Sebat	TARVC	2011
13	Seydişehir	BDIARI	2004
14	Somun Yıldızı	SM	2020
15	Yeniçeri	BDIARI	2013

AAIR: Aegean Agricultural Research Institute, BDIARI: Bahri Dagdas International Agrıcultural Research Institute, SM: Som Un Seed Company, TARVC: Trakya Agriculture and Veterinary Company, TARI:Trakya Agrıcultural Research Institute

The soil characteristics of the trial area are as follows: clayey texture, slightly acidic in nature, non-saline, very low in lime content, very low in phosphorus suitable for plants, low in potassium, and high in nitrogen and organic matter content (Table 2).

Table 2. Soil analysis of the trial area

Texture (ml $100g^{-1}$)	Ph	Total Saline (%)	Lime (%)	Organic Matter (%)	Total Nitrogen	Phosphorus (kg da^{-1})	Potassium (kg da^{-1})
Clay (86)	6.41	0.033	0.000	4.874	0.244	0.57	26

When the long-term average of Düzce province is examined, the average temperature is 12.5 °C and the total precipitation is 811.4 mm, while the average temperature is recorded as 14.5 °C and the total precipitation is 1027.5 mm in the 2021-2022 (November-July) growing period (Table 3).

Sowing was done manually in 5-meter-long plots with a spacing of 20 cm between rows and 6 rows per plot, resulting in 500 seeds per square meter in the second week of November. The plot sizes in the trial were maintained at 6 square meters both at the time of sowing and at harvest time.

In this study, panicle length, grain number per panicle, grain weight per panicle, thousand kernel weight, test weight, groat percentage and grain yield were investigated.

Weed control was performed manually in the trial plots, and no treatments were applied for diseases and pests. With sowing, 5 kg da^{-1} nitrogen and 5 kg da^{-1} phosphorus were applied per decare in pure form, the

top fertilizer was divided into two and 9 kg da^{-1} nitrogen was applied during the tillering period and 6 kg da^{-1} nitrogen was applied during the jointing stage. Harvest was done in the second week of July.

Table 3. Some climate data of Düzce province growing year and long term average

Months	Temperature (ºC)		Precipitation (mm)	
	2021-2022	Long Term	2021-2022	Long Term
November	11.6	9.4	61.2	76.5
December	9.6	5.7	72.5	100.9
January	3.6	3.7	176.0	91.3
February	6.7	5.2	111.0	70.4
March	5.8	7.6	96.3	73.9
April	14.0	12.2	46.4	59.3
May	17.4	16.5	20.0	62.8
June	21.5	20.3	204.2	70.5
July	22.7	22.4	23.8	45.1
Mean	**12.5**	**11.4**		
Total			**811.4**	**650.7**

Long term: 1959-2022 years

In the research, the obtained results were compared using the Duncan test for means comparison. Correlation and principal component analyses were calculated based on the average data and evaluated using the biplot approach (JMP 15.1 SAS Institute Inc, 2020). While correlation analyzes were performed using the JMP program, visualization was made using the ggplot2 package in R software (Wickham, 2009).

3. Results and Discussion

The variance analysis results of the features examined in the study are given in Table 4. Differences between cultivars in all examined traits were found to be statistically significant at the $P \leq 0.01$ level (Table 4). The means for oat cultivars panicle length, grain number per panicle, grain weight per panicle, and thousand kernel weight are given in Table 5, while the averages for test weight, groat percentage, and grain yields are provided in Table 6.

Table 4. Variance analysis table of oat cultivars

Traits		Replication	Cultivars	Error
Panicle length	DF	2	14	28
	MS	1.77220	13.64441**	1.5210
Grain number per panicle	DF	2	14	28
	MS	114.7402	681.1622**	50.247
Grain weight per panicle	DF	2	14	28
	MS	0.0964014	0.6644118**	0.086103
Thousand kernel weight	DF	2	14	28
	MS	17.3866	103.4851**	1.7774
Test weight	DF	2	14	28
	MS	0.94419	65.63800**	1.7180
Groat percentage	DF	2	14	28
	MS	2.2586	116.1166**	1.837
Grain yield	DF	2	14	28
	MS	8915.10	13426.04**	1296.9

** Significant at 1%, * Significant at 5% and ns: not significant, DF: Degrees of freedom, MS: Mean square

While the average panicle length of oat cultivars ranged from 13.23 to 20.83 cm, the mean panicle length was determined to be 16.04 cm. The highest panicle length was measured in the cultivar Otağ (20.83 cm), while the shortest panicle length was observed in the cultivar Kehlibar (13.23 cm) (Table 5). In previous studies, it was reported by different researchers that the panicle length varied between 15.7 cm and 47.3 cm (Sobayoğlu and Topal, 2016; Dumlupınar et al., 2017; Keçecioğlu et al., 2021; Mut et al., 2021). In the experiment, the grain number per panicle of oat cultivars varied between 37.83 (Halkalı) and 86.83 (Otağ). The average number of grains per panicle was determined to be 57.41 grains. Among the oat cultivars, cultivar Otağ exhibited the highest mean number of grains per panicle at 86.83, followed by cultivars Somun Yıldızı (74.84), Diriliş (74.67), and Sebat (73.17) as detailed in Table 4. The grain number per panicle, reported by Kara et al. (2007) as 58.8-92.5, Ercan et al. (2016) as 47-215, Dumlupınar et al. (2017) as 25.8-209.9, Uzun and Halil (2019) as 63.13-92.72 and Kahraman et al. (2021) as 64.1-143.5.

In the research, the grain weight per panicle for oat cultivars ranged from 0.96 to 2.75 g, with the lowest grain weight per panicle observed in the cultivar Katmerli and the highest in the cultivar Otağ (Table 5). Some previous studies have reported variations in grain weight per panicle ranging from 0.53 to 4.85 g (Kara et al., 2007; Ercan et al., 2016; Dumlupınar et al., 2017; Mut et al., 2021). The findings regarding grain weight per panicle are in line with the results of previous studies. Grain weight per panicle is an important yield criterion in oat. It is influenced by environmental factors and significantly varies depending on genetic factors (Sabandüzen and Akçura, 2017).

Table 5. Values for panicle length, grain number per panicle, grain weight per panicle, and thousand kernel weight for oat cultivars

Cultivars	PL	GNP	GWS	TKW
Diriliş	18.56 bc	74.67 b	2.36 ab	32.63 ef
Faikbey	16.37 de	40.00 fg	1.53 def	36.85 bc
Fetih	14.28 fg	51.33 def	1.28 efg	25.14 jk
Halkalı	14.43 efg	37.83 g	1.21 fg	30.75 fg
Kahraman	16.56 def	51.00 def	1.48 def	33.52 de
Katmerli	13.34 g	48.88 d-g	0.96 g	19.86 l
Kazan	15.45 def	42.83 efg	1.55 def	33.82 de
Kehlibar	13.23 g	60.66 cd	1.98 bcd	27.16 ıj
Kırklar	16.88 bcd	54.33 de	1.95 bcd	37.25 b
Küçükyayla	14.33 efg	40.33 fg	1.76 cde	42.36 a
Otağ	20.83 a	86.83 a	2.75 a	29.79 gh
Sebat	15.52 cd	73.17 b	1.97 bcd	24.59 k
Seydişehir	18.83 ab	57.00 cd	2.06 bc	34.87 cd
Somun Yıldızı	15.27 d-g	74.84 b	2.13 bc	27.64 hı
Yeniçeri	16.80 bcd	67.50 bc	1.64 c-f	26.30 ıjk
Mean	**16.04**	**57.41**	**1.77**	**30.83**
LSD	2.06	11.86	0.49	2.23
CV	7.68	12.34	16.52	4.32

PL: Panicle lenght, GNP: Grain number per panicle, GWS: Grain weight per panicle, TKW: Thousand kernel weight

The thousand kernel weight of oats to be used in human nutrition is required to be higher than 26 g (Kahraman et al., 2021). The average thousand kernel weight of the

oat cultivars used in the experiment was determined as 30.83 g. In the study, the thousand kernel weight varied between 19.86-42.36 g, the highest thousand kernel weight was obtained in the cultivar Küçükyayla, while the lowest thousand kernel weight was obtained in the cultivar Katmerli (Table 5). Previous studies have reported variations in thousand kernel weight ranging from 16.8 g to 46.9 g (Sobayoğlu and Topal, 2016; Sabandüzen and Akçura, 2017; Dumlupınar et al., 2017; Güngör et al., 2023). Thousand kernel weight can vary depending on genetic and environmental influences and cultivation conditions (Sarı and İmamoğlu, 2011; Dumlupınar et al., 2017; Sabandüzen and Akçura, 2017; Kahraman et al., 2021).

The test weight of oat cultivars ranged from 43.45 to 60.08 kg hl^{-1}, with an average test weight of 49.98 kg hl^{-1}. The cultivars with the highest test weight in the trial were Katmerli (60.08 kg hl^{-1}), Kazan (54.92 kg hl^{-1}), and Küçükyayla (54.86 kg hl^{-1}), while the lowest test weight was observed in Sebat (43.45 kg hl^{-1}), Faikbey (44.19 kg hl^{-1}), Seydişehir (44.33 kg hl^{-1}), and Otağ (44.68 kg hl^{-1}) cultivars (Table 6). Previous studies have reported test weights as follows: Kahraman et al. (2017), 43.9-60.4 kg hl^{-1}; Güngör et al. (2023), 42.1-53.2 kg hl^{-1}. Test weight varies depending on genetic and environmental influences, and cultural practices (Pixley and Frey, 1991; Kahraman et al., 2021; Güngör et al., 2023). It is preferred for oats used for nutritional purposes to have a high groat percentage and a low husk ratio (Kahraman et al., 2017). The average groat percentage of the oat cultivars used in the experiment was determined as 80.17%. In the study, the groat percentage of oat cultivars varied between 74.20-100.0%. In the study, the lowest groat percentage was found in the cultivar Kahraman, and the highest groat percentage was found in the cultivar Katmerli (Table 6). Similar studies found that the grain groat percentage varied between 56.1-78.4% in Kahraman et al. (2017) and 64.7-74.1% in Kahraman et al. (2021).

Table 6. Values related to test weight, grain internal ratio and grain yield of oat cultivars

Cultivars	**TW**	**GP**	**GY**
Diriliş	48.91 e	75.50 fg	414.8 a
Faikbey	44.19 f	76.33 fg	256.0 d-g
Fetih	53.51 bc	83.83 b	220.9 g
Halkalı	48.95 e	79.76 de	250.7 d-g
Kahraman	51.06 de	74.20 g	374.2 ab
Katmerli	60.08 a	100.0 a	286.5 c-f
Kazan	54.92 b	76.00 fg	242.7 efg
Kehlibar	50.11 de	81.60 bcd	393.7 a
Kırklar	51.80 cd	76.83 f	250.5 d-g
Küçükyayla	54.86 b	80.80 cd	302.3 cde
Otağ	44.68 f	82.17 bc	304.6 cd
Sebat	43.45 f	81.06 cd	228.8 fg
Seydişehir	44.33 f	75.76 fg	215.3 g
Somun Yıldızı	49.70 de	77.56 ef	320.5 bc
Yeniçeri	49.13 e	81.16 cd	201.4 g
Mean	**49.98**	**80.17**	**284.2**
LSD	2.19	2.27	60.23
CV	2.62	1.69	12.67

TW: Test Weight, GP: Groat Percentage, GY: Grain Yield

The grain yield of oat cultivars ranged from 201.4 to 414.8 kg da^{-1}. The average grain yield of oat cultivars was determined to be 284.2 kg da^{-1}. The study obtained the highest grain yield in the cultivars Diriliş (414.8 kg da^{-1}) and Kehlibar (393.7 kg da^{-1}). In comparison, the lowest grain yield was observed in the Yeniçeri (201.4 kg da^{-1}), Seydişehir (215.3 kg da^{-1}), and Fetih (220.9 kg da^{-1}) cultivars (Table 6). Similar studies have reported grain yields ranging from 99.2 to 241.4 kg da^{-1} (Sobayoğlu and Topal, 2016), 306.7 to 454.8 kg da^{-1} (Uzun and Halil, 2019), 413.6 to 810.4 kg da^{-1} (Kahraman et al., 2021), and 401.1 to 532.1 kg da^{-1} (Güngör et al., 2023). Grain yield in oats influenced by genetic, cultural practices, and environmental factors (Tamm, 2003; Batalova and Gorbuna, 2009; Kahraman et al., 2017; Güngör et al., 2023).

3.1.Principal components (PCA) biplot analysis

The biplot analysis method has been frequently used recently in plant breeding studies because it makes easier to visually examine the relationships between examined traits and genotypes and evaluate the analysis results (Yan and Kang, 2003; Güngör et al., 2022). In this study, a biplot analysis result, illustrating the relationship between oat cultivars and the examined traits is presented in Figure 1. When examining the GGE biplot graph, PC1 accounted for 46.4%, and PC2 accounted for 24.5% of the total variation, totaling 70.9% (Figure 1). Yan et al. (2000) noted that when PC1 and PC2 approach a total value of around 100%, it indicates that the coefficients of the examined traits are high.

A high level of positive correlation is evident grain yield, panicle length, panicle grain number, and panicle grain weight, indicated by the angles between the vectors representing these traits are less than 90 degrees. Similarly, there is a high level of positive correlation between groat percentage and test weight. It is observed that there is a negative relationship between grain yield and test weight and groat percentage. The distance of the vectors representing the traits from the origin indicates the variation of genotypes regarding the respective trait (Yan et al., 2007).

The vector representing grain yield is the shortest, while the vector representing thousand kernel weight is the longest. It can be expressed that the variation among oat varieties is the lowest grain yield and the highest in thousand kernel weight, groat percentage, and panicle grain number.

Mut et al. (2021) in their study examining the yield and some physical quality characteristics of oat genotypes under rainfall-based and supplementary irrigation conditions, found that there was a positive relationship between grain yield, biological yield and thousand kernel weight under rainfall-based conditions, and that test weight and grain internal ratio characteristics They reported that grain yield, biological yield, thousand kernel weight and test weight traits had a positive relationship with each other under supplementary irrigation conditions. Hocaoğlu et al. (2022) reported in their study that there was a close relationship between grain yield and thousand kernel weight characteristics, and Güngör et al. (2023) reported that there was a positive relationship between grain yield, thousand kernel weight, test weight and protein ratio.

When examining the biplot analysis graph, cultivar Diriliş stands out in terms of grain yield, grain number per panicle, grain weight per panicle, and panicle length, while cultivar Fetih stands out in terms of test weight and groat percentage.

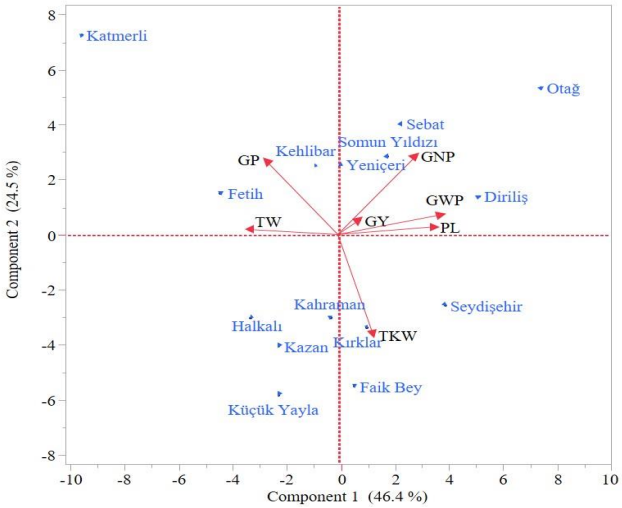

Figure 1. Biplot graphic showing the relationship between oat cultivars

The results of the correlation coefficient analysis for the study are shown in Figure 2. The correlation coefficient analysis indicates the relationships between the examined traits. Positive correlations were observed between grain yield and test weight (r=0.012), panicle grain number (r=0.248), panicle grain weight (r=0.328), and thousand kernel weight (r=0.076), while negative correlations were found between groat percentage (r=-0.109) and panicle length (r=-0.058).

There is a significant positive relationship between test weight and the groat percentage (r=0.538*). A positive and significant relationship exists between panicle length and panicle grain number (r=0.608*) and panicle grain weight (r=0.747**), while it has a negative and significant relationship with test weight (r=0.656**). There is a positive and significant relationship between panicle grain weight and panicle grain number (r=0.782*), while there is a negative relationship between panicle grain number and test weight (r=-0.448). A negative and significant relationship was determined between thousand kernel weight and groat percentage (r=-0.656**).

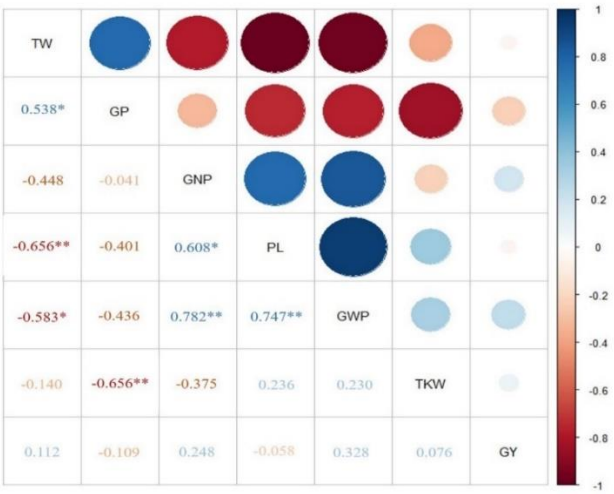

Figure 2. Correlation relationship for the examined features

Dumlupınar et al. (2017) reported that plant height, panicle length, grain number per panicle, grain weight per panicle and thousand kernel weight are important selection criteria in increasing grain yield. Sarı and Ünay (2015) reported that there was a positive correlation between grain yield and test weight and grain weight per panicle. Güngör et al. (2023) found that grain yield had a positive and significant correlation with test weight and thousand kernel weight.

4. Conclusion

This research was conducted in Düzce province during the 2021-2022 growing season using 15 oat cultivars. Significant differences were found among the cultivars regarding all the examined traits. When the biplot and correlation analysis are considered together, it was determined that there is a positive relationship between grain yield and grain number per panicle and grain weight per panicle. Conversely, a negative and significant relationship exists between thousand kernel weight and groat percentage. Additionally, a positive and significant relationship was observed between panicle length grain number per panicle and grain weight per panicle. In terms of grain yield, the cultivars Diriliş and Kehlibar stood out.

Declaration of Author Contributions

The authors declare that they have contributed equally to the article. All authors declare that they have seen/read and approved the final version of the article ready for publication.

Declaration of Conflicts of Interest

All authors declare that there is no conflict of interest related to this article.

References

Batalova, G.A., Gorbunova, L.A., 2009. Oat yield and seed quality depending on sowing rate. *Russian Agricultural Sciences*, 35(1): 18-19.

Buerstmayr, H., Krenn, N., Stephan, U., Grausgruber, H., Zechner, E., 2007. Agronomic performance and quality of oat (*Avena sativa* L.) genotypes of worldwide origin produced under central European growing conditions. *Field Crops Research*, 101(3): 341-351.

Dumlupınar, Z., Maral, H., Kara, R., Dokuyucu, T., Akkaya, A., 2011. Evaluation of turkish oat landraces based on grain yield, yield components and some quality traits. *Turkish Journal of Field Crops*, 16(2): 190-196.

Dumlupınar, Z., Güngör, H., Dokuyucu, T., Akkaya, A., 2017. Determination of relationships between grain yield and some agronomic traits by correlation and path analysis in oat (*Avena* spp.). *Journal of Tekirdag Agricultural Faculty*, 14(1): 61-68.

Ercan, K., Tekin, A., Herek, S., Kurt, A., Kekeç, E., Olgun, M.F., Dokuyucu, T., Dumlupınar, Z., Akkaya, A., 2016. Performance of local oat lines in Kahramanmaraş conditions. *KSU Journal of Natural Sciences*, 19(4): 438-444.

Finnan, J., Burke, B., Spink, J., 2019. The effect of nitrogen timing and rate on radiation interception, grain yield and grain quality in autumn sown oats. *Field Crops Research*, 231: 130-140.

Flander, L., Suortti, T., Katina, K., Poutanen, K., 2010. Effects of wheat sourdough process on the quality of mixed oat-wheat bread. *Food Science and Technology*, 44: 656-664.

Güngör, H., Çakır, M.F., Dumlupınar, Z., 2022. Evaluation of wheat genotypes: genotype × environment interaction and GGE biplot analysis. *Turkish Journal of Field Crops*, 27(1): 149-157.

Güngör, H., Çakır, M.F., Dumlupınar, Z., 2023. Determination of grain yield and agricultural traits of some oat cultivars at different locations. *Black Sea Journal of Agriculture*, 6(4): 350-355.

JMP®, Version 15.1. SAS Institute Inc., Cary, NC, 1989–2020.

Kahraman, T., Avcı, Y.R., Kurt, C., 2017. Determination of grain yield, quality and agronomic traits of some oat (*Avena sativa* L.) genotypes. *Journal of Central Research Institute for Field Crops,* 26 (Special Issue): 74−79.

Kahraman, T., Avcı, R., Yıldırım, M., 2021. Determination of grain yield, yield components and quality traits of oat genotypes (*A. sativa* L.). *KSU Journal of Natural Sciences*, 24(5): 1003-1010.

Kapoor, R., Bajaj, R.K., Sidhu, N., Kaur, S., 2011. Correlation and path coefficient analysis in oat (*Avena sativa* L.). *International Journal of Plant Breeding*, 5(2): 133-136.

Kara, R., Dumlupınar, Z., Hışır, Y., Dokuyucu, T., Akkaya, A., 2007. Evaluation of oat varieties in terms of grain yield and yield components in Kahramanmaraş conditions. *Türkiye VII. Field Crops Congress, 25-27 June*, Erzurum.

Keçecioğlu, Y., Kara, R., Dokuyucu, T., 2021. Determination of genetic differences and improvements of some oat genotypes in terms of morphological and agricultural characteristics. *Turkish Journal of Agricultural and Natural Sciences*, 8(1): 103-115.

Marjanović-Jeromela, A., Marinković, R., Mijić, A., Jankulovska, M., Zdunić, Z., 2007. Interrelationship between oil yield and other quantitative traits in rapeseed (*Brassica napus* L.). *Journal of Central European Agriculture*, 8(2): 165-170.

Marshall, A., Cowan, S., Edwards, S., Griffiths, I., Howarth, C., Langdon, T., White, E., 2013. Crops that feed the world 9. Oats-a cereal crop for human and livestock feed with industrial applications. *Food Security*, 5(1): 13-33.

Mut, Z., Erbaş Köse, Ö.D., Akay, H., Sezer, E., 2021. Evaluation of some characteristics of local oat genotypes collected from the central and western black sea region. *Journal of the Institute of Science and Technology*, 11(2): 1582-1594.

Pixley, K.V., Frey, K.J., 1991. Inheritance of test weight and its relationship with grain yield of oat. *Crop Science*, 31: 36-40.

Sabandüzen, B., Akçura, M., 2017. Evaluation of grain yield and yield components of oat genotypes in Çanakkale conditions. *Turkish Journal of Agricultural and Natural Sciences*, 4(2): 101-108.

Sarı, N., İmamoğlu, A., 2011. Determination of Improved Oat Lines Suitable for Menemen Ecologial Conditions. *Journal of Aegean Agricultural Research Institute*, 21(1): 16-25.

Sarı, N., İmamoğlu, A., Yıldız, Ö., 2012. Yield and quality characteristics of some advanced oat lines in Menemen ecological conditions. *Journal of Aegean Agricultural Research Institute*, 22(1): 18-32.

Sarı, N., Ünay, A., 2015. Determining characteristics affecting grain yield of oats (*Avena sativa* L.). *Journal of Central Research Institute for Field Crops*, 24(2): 115-123.

Sobayoğlu, R., Topal, A., 2016. Evaluation of spring sown oat genotypes (*Avena sativa* L.) in terms of yield and yield components under Karaman conditions. *Journal of Bahri Dagdas Crop Research*, 5(1): 28-34.

Şahin, M., Akçacık, A.G., Aydoğan, S., Hamzaoğlu, S., Çeri, S., Demir, B., 2017. Determination of some physical traits and nutrient components in oat (*Avena sativa* spp.) *Journal of Bahri Dagdas Animal Research,* 6(1): 23-28.

Şahin, M., Çeri, S., Göçmen Akçacık, A., Aydoğan, S., Hamzaoğlu, S., Demir, B., 2019. Investigation of relationships between yield and technological properties of winter oat (*Avena sativa* spp.) genotypes. *Journal of Bahri Dagdas Crop Research,* 8(1): 34-42.

Tamm, I., 2003. Genetic and environmental variation of grain yield of oat varieties. *Agronomy Research,* 1: 93-97.

TUİK, 2023. Turkish Statistical Institute, (https://www.tuik.gov.tr/), (Accessed on 18.05.2023).

Uzun, A., Halil, D.S., 2019. Seed yield and some quality characteristics of oat (*Avena sativa* L.) genotypes growing at Bursa ecological conditions. *Journal of Agricultural Faculty of Bursa Uludag University*, 33(2): 293-305.

Valentine, J., Cowan, A.A., Marshall, A.H., 2011. Oat breeding. Oats chemistry and technology. Chapter 2. International Standard Book Number: 978-1-891127-64-9.

Wickham, H., 2009. ggplot2: Elegant graphics for data analysis. Springer-Verlag New York.

Yan, W., Hunt, L.A., Sheng, Q., Szlavnics, Z., 2000. Cultivar evaluation and mega-environment investigation based on the GGE biplot. *Crop Science,* (40): 597–605.

Yan, W., Kang, M., 2003. GGE biplot analysis. A graphical tool breeders. Geneticists and agronomists. 1St Edn, CRC Press. Florida.

Yan, W., Tinker, N.A., 2006. Biplot analysis of multienvironment trial data: Principles and applications. *Canadian Journal of Plant Science,* 86: 623–645.

Yan, W., Kang, M.S., Ma, B., Woods, S., Cornelius, P.L., 2007. GGE biplot vs. AMMI analysis of genotype by-environment data. *Crop Science,* 47: 643-655.

To Cite	Güngör, H., Çakır, M.F., Kantar, B.H., Gedik, B., Dumlupınar, Z., 2023. Evaluation of Some Oat Cultivars for Grain Yield, Yield Components and Quality Traits in Düzce Ecological Conditions. *ISPEC Journal of Agricultural Sciences*, 7(4): 718-729. DOI: https://doi.org/10.5281/zenodo.10207705.