INVESTIGATION OF YIELD AND YIELD COMPONENTS OF RAPESEED (BRASSICA NAPUS SSP. OLEIFERA L.) GENOTYPES IN TRAKYA REGION CONDITIONS

INVESTIGACIÓN DEL RENDIMIENTO Y LOS COMPONENTES DEL RENDIMIENTO DE LA COLZA (BRASSICA NAPUS SSP. OLEIFERA L.) GENOTIPOS EN CONDICIONES DE LA REGIÓN TRAKYA

Mustafa Yaşar[1]*; Mehmet Sezgin[2]

1. Muş Alparslan University, Muş, Türkiye. mustafa.yasar@alparslan.edu.tr
2.Ankara Variety Registration and Seed Certification Center, Ankara, Türkiye. mehmet.sezgin@tarimorman.gov.tr

* Corresponding author: Mustafa Yaşar, e-mail:mustafa.yasar@alparslan.edu.tr

ABSTRACT

The genotype*environment interaction was investigated in terms of yield and yield components of rapeseed varietys and candidate varietys depending on the years the research was carried out in Tekirdağ conditions. This research; In 2014-2015 and 2015-2016, 9 rapeseed cultivars and cultivar candidates were carried out in Tekirdağ location with 4 replications according to the Randomized Complete Block Design. In the analysis of variance, significant differences were found at the level of $P < 0.01$ and $P < 0.05$ in terms of yield and yield components in terms of genotype, year and year*genotype interaction statistically. According to the results of the analysis, the average yield of the genotypes varied between 2854-5356 kg ha^{-1}, and the average of the years ranged between 3356-5121 kg ha^{-1}. NK Caravel, candidate 1 (DK Ekstorm), candidate 3 (DK Expower) and candidate 4 (NK Linus) varieties have come to the fore in rapeseed cultivation in Tekirdağ conditions. The best results in terms of seed yield and yield components were obtained from NK Caravel, candidate 4 (NK Linus) and PR44W29 varietys. As a result, year, genotype and year*genotype interactions were examined in terms of yield and yield components of cultivars in rapeseed cultivation, and it was concluded that NK Caravel, candidate 4 (NK Linus) and PR44W29 cultivars showed high performance in Tekirdağ conditions, and the effect of the environment was higher than the effect of genotype.

Keyword: Rapeseed; yield; yield components; Interaction; Tekirdağ.

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RESUMEN

La interacción genotipo*ambiente se investigó en términos de rendimiento y componentes de rendimiento de variedades de colza y variedades candidatas dependiendo de los años en que la investigación se llevó a cabo en condiciones de Tekirdağ. Esta investigación; En 2014-2015 y 2015-2016, se llevaron a cabo 9 cultivares de colza y candidatos a cultivares en la ubicación de Tekirdağ con 4 réplicas de acuerdo con el Diseño de Bloque Completo Aleatorio. En el análisis de varianza, se encontraron diferencias significativas a nivel de $P < 0,01$ y $P < 0,05$ en términos de rendimiento y componentes de rendimiento en términos de interacción genotipo, año y año*genotipo estadísticamente. Según los resultados del análisis, el rendimiento promedio de los genotipos varió entre 2854-5356 kg ha^{-1}, y el promedio de los años osciló entre 3356-5121 kg $^{-1}$. Las variedades NK Caravel, candidata 1 (DK Ekstorm), candidata 3 (DK Expower) y candidata 4 (NK Linus) han pasado a primer plano en el cultivo de colza en condiciones de Tekirdağ. Los mejores resultados en términos de rendimiento de semillas y componentes de rendimiento se obtuvieron de las variedades NK Caravel, candidatas 4 (NK Linus) y PR44W29. Como resultado, se examinaron las interacciones año, genotipo y año*genotipo en términos de rendimiento y componentes de rendimiento de cultivares en el cultivo de colza, y se concluyó que los cultivares NK Caravel, candidato 4 (NK Linus) y PR44W29 mostraron un alto rendimiento en condiciones de Tekirdağ, y el efecto del medio ambiente fue mayor que el efecto del genotipo.

Palabra clave: Colza; rendimiento; componentes de rendimiento; Interacción; Tekirdağ

INTRODUCTION

Rapeseed (Brassica napus ssp. oleifera L.) is one of the most cultivated oil crops in the world, rich in protein, fat and carbohydrates. It is one of the industrial plants that ranks second in oil production with a share of 73.6 million tons and 12% among the oilseed plants produced in the world (Carre and Pouzet, 2014; SoyStat, 2022). Rapeseed is one of the most preferred oilseeds in the vegetable oil industry because it contains 45-50% oil. In addition, high protein content (30%) offers an advantage in the evaluation of rapeseed meal in the feed industry (Schmidt et al. 2004; Çetiner and Ersus Bilek, 2019). Rapeseed is important in terms of contributing to biodiesel production and meeting the protein needs of livestock (Raymer, 2002), improving the organic structure and soil cover of the soil, and reducing weeds (Chan and Heenan, 1996; Hansen et al., 2018) by including it in the rotation system. High flowering in rapeseed also encourages biodiversity (Eberler et al. 2015).

According to FAOSTAT data, the countries producing more than 35.5 million rapeseeds in the world in 2020 are Canada, China, India, Germany and France. Turkey is behind the world rankings in 2021 with 140 thousand tons of rapeseed production in an area of 38 thousand hectares. More attention should be paid to rapeseed studies both in Turkey and in the world, in order to combat the drought that has arisen with global warming and to eliminate the vegetable oil deficit, which has become more important in the food crisis.

Approximately 33% of rapeseed production in Turkey is produced in Tekirdağ (TUIK, 2022). Varieties that adapt more easily to climatic conditions and show higher seed yield and oil yield performance are

more preferred by producers. In general terms, as in all plant groups, the performances of the cultivars vary in different environments in the rapeseed plant. It is important to grow stable varieties that adapt to environmental changes in regions where crops of economic importance are grown (Jensen 1988). Therefore, it is necessary to determine the adaptability of the varieties to the environment. In order to determine the adaptation of the varieties to be used to the environment, trials are carried out in various years and locations, and various models are developed to calculate the genetic parameters of the studied characters (Comstock and Mool 1963).

The fact that both yield and other characteristics are affected by different environmental conditions in studies increases the importance of environment genotype interaction. The G x E (Genotype x environment) interaction is defined by the variation in performance of varieties according to changing environmental conditions. However, if this interaction does not change the yield order of genotypes in different environments, there is no problem in terms of cultivar proposal (Atakış and Kaya, 2002). The G x E interaction shows itself in studies on yield performance. However, the main purpose of yield studies is to predict the performance of the best variety in the future using available data. Genotype*environment effect is the biggest obstacle in determining the effectiveness of a genotype in different environments and choosing stable genotypes, affecting yield and production (Khomari et al., 2017; Ansarifard et al., 2020). In addition, many different studies have been carried out to determine stable varieties in terms of seed yield and to reveal the effect of GE interaction (Coskun and Ozturk, 2014; Begna and Angadi, 2016; Süzer, 2016; Dolgun et al., 2019; Soysal and Bayram, 2022).

It can be said that differences in breeding practices are also important, as well as the differences in yield, environmental conditions and genetic structures of varieties are effective in studies carried out in different environments. Therefore, attention should be paid to these while selecting varieties, varieties should be selected according to the results of variety yield and adaptation trials, and the principles of rapeseed cultivation technique should be fully complied with (Arslan et al., 2007; Sargın, 2012).

The main purpose of this study is to reveal the effect of year, genotype and interaction from the data of yield and yield elements obtained from the study conducted in Tekirdağ environmental conditions in rapeseed cultivation, to determine the stable varieties and to suggest suitable varieties for the region.

MATERIAL AND METHOD

Materiel: In the study, 5 rapeseed varietys and 4 rapeseed candidate varietys were used as material in Tekirdag conditions in 2014-2015 and 2015-2016 production seasons. The information on the varietys and candidate varietys used in the study is presented in Table 1, the location information in Table 2, and the climatic values of the location in detail in Table 3. Candidate 1, Candidate 3 and Candidate 4 used in the study were registered with the same name, and Candidate 2 under the name Samibey in 2017.

Table 1. Some information about the varieties

VARIETYS	VARIETY OWNER ORGANIZATION	REG. YEAR	PLACE OF BREEDING	THOUSAND SEED WEIGHT (G)	PLANT HEIGHT (CM)	FIRST FLOWERING DAY	PHYSIOLOGICAL MATURITY NUMBER OF DAY	CAPSULE NUMBER PER PLANT	OIL RATIO (%)
NK CARAVEL	Syngenta Agriculture Industry and Trade Inc.	2012	Czech Republic	3.1-3.7	150-170	167-188	228-249	118-213	49.0
SÜZER	Trakya Agricultural Research Institute Directorate	2012	Türkiye	3.4-3.6	164-190	167-190	229-249	138-205	47.2
PR44W29	Pioneer Seed Distribution and Marketing Ltd. Sti.	2013	France	3.2-4.2	120-175	172-192	234-251	109-194	50.3
EXCALIBUR	Monsanto Food and Agriculture Trade. Ltd. Sti.	2012	France	3.4-3.9	135-170	165-184	230-246	136-201	49.5
CHAMPLAIN	Limagrain Seed Breeding and Production Industry. Trade Inc.	2012	France	2.9-3.5	155-180	169-196	231-254	128-228	47.1
ADAY 1 (DK EKSTORM)	Monsanto Food and Agriculture Trade. Ltd. Sti.	2017	France	2.7-4.5	128-188	160-186	231-266	160-444	43.6
ADAY 2 (TK-05-14)	Trakya Agricultural Research Institute Directorate	2017	Türkiye	3.9-5.3	138-195	158-187	229-265	162-369	37.4
ADAY 3 (DK EXPOWER)	Monsanto Food and Agriculture Trade. Ltd. Sti.	2017	France	3.9-5.3	129-180	152-186	225-266	139-362	43.0
ADAY 4 (NK LINUS)	Syngenta Agriculture Industry and Trade Inc.	2017	Germany	2.9-4.7	117-190	158-187	229-265	123-248	39.1

Source: Ankara Variety Registration and Seed Certification Center-2022.

Table 2. Information about the location

LOCATION COORDINATES			
LOCATION	Altitude (m)	Latitude	Longitude
TEKIRDAĞ/ÇORLU/MAKSUTLU	84	41° 4'49.16"K	27°39'42.13"D

Table 3. Climate data of locations

CLIMATE FACTORS									
LOCATION	**TOTAL PRECIPITATION (MM)**			**AVERAGE TEMPERATURE (°C)**			**AVERAGE HUMIDITY (%)**		
TEKIRDAĞ/ÇORLU/MAKSUTLU	**YEARS**			**YEARS**			**YEARS**		
MONTHS	2000-2022 (long years)	2014-2015	2015-2016	2000-2022 (long years)	2014-2015	2015-2016	2000-2022 (long years)	2014-2015	2015-2016
SEPTEMBER	39.1	111.2	79.5	26.5	26	28.9	71.0	77.9	71.5
OCTOBER	53.6	97.8	79.5	20.9	19.7	19.8	75.4	79.3	82.3
NOVEMBER	49.1	35.2	30.9	15.7	14.1	18	83.0	86.5	79.6
DECEMBER	52.9	83.9	4	10.7	11	10.5	85.2	90.5	87.6
JANUARY	68.8	58.1	97.6	8.4	8.8	8.6	84.3	83.1	84.2
FEBRUARY	55.0	70.7	76.3	10.6	9.6	14.9	82.7	77.7	86.6
MARCH	42.7	40	24.6	13.1	12.5	15.6	76.9	80	83.7
APRIL	43.5	71.4	15.3	18.3	18.1	22.6	71.3	68.5	69.5
MAY	45.7	4.4	45.6	23.2	25.4	24	71.7	68	74.4
JUNE	86.0	71.6	123	27.6	27.5	30.4	72.5	68.5	70.1
JULY	30.6	2.4	0	29.9	32.1	32	68.1	63.1	65.6

Source: General Directorate of Meteorology-Ankara

Method: This study was carried out according to the Randomized Complete Block Design with 4 replications. Trial sowing was done on 01 October 2014 and 03 October 2015. In the experiments, planting depth was determined as 1-2 cm, spacing between rows 35 cm, spacing between rows 3 cm (150 seeds), plot length of 5 m and 5 rows. Only the middle 3 rows were harvested in the experiment. In the experiment, 15 kg.da^{-1} pure N (5 kg.da-1 in autumn, 10 kg.da^{-1} in the period before uptake), 15 kg.da^{-1} K2O and 10 kg.da^{-1} P2O5 fertilizers were used. In the research; first flowering days (days), physiological maturity number of day (days), plant height (cm), number of side branches, number of capsules per plant (capsule plant^{-1}), number of seeds in capsule (seed capsule^{-1}) and oil ratio (%) observations were taken according to the instructions of Ankara Variety Registration and Seed Certification Center for measuring rapeseed agricultural values (Anonymous, 2001). Harvesting was carried out when the leaves turned yellow in 75% of the plants (07 July 2015 and 28 June 2016).

Statistical Analysis: The combined variance analysis of the data obtained from the research was made using the JMP Pro 13 package program and the factors found to be important were evaluated and grouped according to the LSD test.

RESULTS AND DISCUSSION

The variance analysis values of the traits examined in the study are given in Table 4, and statistically significant differences at the level of 1% and 5% were found between the year, genotype and

year*genotype interaction in terms of all the traits examined in Table 4. In addition, the averages of the first flowering days and the number of physiological maturity day and the resulting groups are in Table 5, the averages of the plant height and the number of branches and the resulting groups are in Table 6, the averages of the number of capsules in the plant and the number of seeds in the capsule and the resulting groups are in Table 7., the averages of seed yield and oil content traits and the resulting groups are given in Table 8, and the correlation values of the bilateral relations between the examined traits are given in Table 9.

Table 4. Variance analysis table for the examined traits

VARIATION SOURCES	DF	SEED YIELD	FIRST FLOWERING DAY	PHYSIOLOGICAL MATURITY NUMBER OF DAY	PLANT HEIGHT	NUMBER OF BRANCHES	CAPSULE NUMBER PER PLANT	NUMBER OF SEEDS IN THE CAPSULE	OIL RATIO
MODEL	23	15146.1	24.0531	13.654	314.659	7.843	26688.1	14.9203	11.925
YEAR	1	66339	460.056**	268.347**	2211.12	26.8889**	534061**	0	169.035**
ERROR 1	6	12312.2	3.99074	0.49537	390.755	1.65741	1111.07	7.11111	0.32787
GENOTYPE	8	22551.3**	5.65972	3.71181**	171.219**	11.0556**	5157.75**	16.2813**	10.9414**
YEAR*GENOTYPE	8	3467.29	2.99306	1.62847*	163.969**	6.88889**	3979.53**	21.2813**	1.96788
ERROR 2	48	2190.6	3.4282	0.735	33.015	0.78241	228.5	3.3924	0.9758
DK (%)		10.74	0.98	0.32	3.37	10.37	6.34	8.91	2.59

**, p<0.01, *0.01<P<0.05, CV: coefficient of variation; DF: degrees of freedom

Physiological maturity number of day

In terms of the number of physiological maturity number of day of the genotypes; year and genotype were found to be statistically significant at the level of 1%, and year*genotype interaction at the level of 5% (Table 4). Physiological maturity number of day varied between 265.7 and 269.5 days depending on the years. In the 2014-2015 growing season, in which the research was conducted, a shorter physiological death time was calculated compared to the 2015-2016 growing season. It is thought that the rainfall in May and June is effective in the longer duration of the physiological maturity period in the 2015-2016 growing season. In particular, the 2015-2016 growing season has been an extreme year for the month of June compared to the total precipitation for long years (Table 3). Physiological maturity number of day of the genotypes varied between 266.5 and 268.6 days. The longest physiological maturity number of day was found in Süzer variety, and the shortest physiological death time was determined in candidate 4 (NK Linus). In the genotype*environment interaction, the physiological maturity number of day varied between 264.55 and 270.3 days. The longest physiological maturity number of day was determined from the 2015-16 growing season and varietys PR44W29 and Excalibur, while the shortest physiological maturity number of day was determined from the 2014-15 growing season and candidate 2, candidate 4 and PR44W29 varietys (Table 5). The fact that the PR44W29 variety has both the shortest and the longest physiological maturity number of day depending on the years shows that this variety responds quickly to different environmental conditions. Obtaining the shortest and longest physiological maturity number of day values from different years shows that the physiological maturity number of day period is mostly under the influence of different climatic characteristics of the years.

First flowering day

In terms of the first flowering days of the genotypes; While statistically significant differences were observed at the level of 1% between years, no statistical difference was found between genotypes and in terms of year*genotype interaction (Table 4). The number of first flowering days depending on the years; It varied between 185.9-191.0 days (Table 5). At the end of March and the beginning of April, which is the beginning of the first flowering day, the 2014-2015 growing season was an extreme year, especially in terms of monthly total precipitation, compared to the average of many years. In the 2014-2015 growing season, the excess precipitation and the low temperature compared to long years affected the seed yield negatively. It shows that the number of first flowering days changes depending on the years and this trait is affected by the climate characteristics of the years.

Table 5. The averages of the first flowering days and the physiological maturity number of day and the resulting groups

GENOTYPES	PHYSIOLOGICAL MATURITY NUMBER OF DAY (DAY)			FIRST FLOWERING DAY (DAY)		
	2014-2015	2015-2016	AVERAGE	2014-2015	2015-2016	AVERAGE
NK CARAVEL	265.5 ef	270.0 ab	267,8 BC	186,0	191,5	188,8
SÜZER	267.3 d	270.0 ab	268,6 A	186,3	191,3	188,8
PR44W29	265.0 f	270.3 a	267,6 B-D	186,5	191,5	189,0
EXCALIBUR	265.5 ef	270.3 a	267,9 A-C	186,5	191,5	189,0
CHAMPLAIN	266.8 d	270.0 ab	268,4 AB	187,0	191,8	189,4
CANDIDATE 1 (DK EKSTORM)	265.5 ef	268.8 c	267,1 C-E	186,0	190,3	188,1
CANDIDATE 2 (TK-05-14)	264.8 f	269.0 bc	266,9 DE	182,5	190,5	186,5
CANDIDATE 3 (DK EXPOWER)	266.3 de	269.0 bc	267,6 B-D	186,3	190,5	188,4
CANDIDATE 4 (NK LINUS)	264.5 f	268.5 c	266,5 E	186,3	190,0	188,1
AVERAGE	265.7 B	269.5 A		185,9 B	191,0 A	
LSD 0.05 YEAR		0.4			1.15	
LSD 0.05 GENOTYPE		0.86				
LSD 0.05 YEAR*GENOTYPE		1.21				

LSD: Low singificant difference

Plant height

In terms of plant height; genotype and year*genotype interaction was found to be statistically significant at the 1% level (Table 4). There was no statistically significant difference between years. Plant heights of genotypes; It varied between 163.1-179.1 cm (Table 6). In the year*genotype interaction, the shortest plant height was obtained from candidate 4 with 153.8 cm in 2014-2015, and the longest plant height was obtained from candidate 2 genotypes and candidate 1 genotype in the same group with 182.5 cm in 2015-2016. Except for Süzer variety, the change in plant heights over the years in all genotypes indicates that the effect of the environment is very dominant.

Number of branches

In terms of the number of branches (pieces); year, genotype and year*genotype interaction were found to be statistically significant at the 1% level (Table 4). It varied between 7.9-9.1 (pieces) per plant on yearly basis. Number of branches of genotypes; It varied between 7.4-11-1 pieces. The highest number of branches was obtained from Excalibur variety with 11.1 and the lowest number of side branches

was obtained from Süzer (7.4 pieces) and candidate 3 (7.5 pieces). In the year*genotype interaction, the least number of branches was obtained from candidate 3 in 2014-2015 growing season, candidate 4 in the same group, and Süzer genotypes in 2015-2016 growing season with 6.3 pieces, and the highest number of branches was obtained from Excalibur variety in 2015-2016 growing season with 13.0 pieces. . The variation in the values of all genotypes except for the Champlain cultivar indicates that this trait is mostly influenced by the environment (Table 6).

Table 6. Averages and groups related to plant height and number of branches

GENOTYPES	PLANT HEIGHT (CM)			NUMBER OF BRANCHES		
	2014-2015	2015-2016	AVERAGE	2014-2015	2015-2016	AVERAGE
NK CARAVEL	167.5 ef	180.3 ab	173,9 AB	7,0 de	9,0 bc	8,0 CD
SÜZER	180.0 ab	178.3 a-c	179,1 A	8,3 cd	6,5 e	7,4 D
PR44W29	166.3 e-g	167.5 ef	166,9 CD	8,5 c	8,0 cd	8,3 CD
EXCALIBUR	165.0 e-g	171.3 c-e	168,1 B-D	9,3 bc	13,0 a	11,1 A
CHAMPLAIN	166.3 e-g	177.5 a-d	171,9 BC	8,0 cd	8,0 cd	8,0 CD
CANDIDATE 1 (DK EKSTORM)	158.8 gh	182.0 a	170,4 BC	9,3 bc	10,0 b	9,6 B
CANDIDATE 2 (TK-05-14)	160.0 f-h	182.5 a	171,3 BC	8,3 cd	9,0 bc	8,6 C
CANDIDATE 3 (DK EXPOWER)	164.5 e-g	170.0 de	167,3 CD	6,3 e	8,8 bc	7,5 D
CANDIDATE 4 (NK LINUS)	153.8 h	172.5 b-e	163,1 D	6,5 e	10,0 b	8,3 CD
AVERAGE	164.7	175.8		7,9 B	9,1 A	
LSD 0.05 YEAR					0.74	
LSD 0.05 GENOTYPE		5.77			0.88	
LSD 0.05 YEAR*GENOTYPE		8.16			1.25	

LSD: Low singificant difference

Number of capsules per plant (per plant^{-1})

In terms of the number of capsules in the plant; year, genotype and year*genotype interaction were found to be statistically significant at the 1% level (Table 4). By years, the number of capsules per plant was found to be 152.1 in 2014-15 and 324.3 in 2015-16 (Table 7). The number of capsules per plant of genotypes; The lowest number of capsules, varying between 199.1-277.6 pieces, was obtained from Süzer, and the maximum number of capsules was obtained from Excalibur variety. In the year*genotype interaction, the number of capsules varied between 136.3 and 401.5. The highest number of capsules was obtained from Excalibur variety with 401.5 in 2015-16 growing season, and the lowest number of capsules was obtained from Candidate 4 (NK Linus), Candidate 3 (DK Expower) and PR44W29 genotypes in 1014-15 growing season. Obtaining the highest and lowest capsule numbers from different years and genotypes shows the effect of interaction. Especially, this change in PR44W29, Excalibur, Champlain, Candidate 1 (DK Ekstorm), Candidate 3 (DK Expower) genotypes shows that rapeseed genotypes are sensitive to bad and good environmental conditions.

Number of seeds in capsule (piece capsule^{-1})

In terms of the number of seeds in the capsule; There were statistically significant differences at the level of 1% in terms of genotype and year*genotype interaction, and there was no statistically significant difference between years (Table 4). The number of seeds in the capsule in genotypes; It

varied between 18.9-23.1 piece capsule^{-1} (Table 7). The highest number of seeds in the capsule was obtained from NK Caravel variety, and the lowest number of seeds in the capsule was obtained from candidates 2 (Süzer) and candidates 3 (DK Expower). In the year*genotype interaction, the number of seeds in the capsule varied between 16.0 and 24.5. The minimum number of seeds in the capsule was obtained from the Candidate 3 (DK Expower) genotype with 16.0 in 2014-2015, the maximum number of seeds in the capsule was obtained from the Candidate 1 (DK Ekstorm) genotype with 24.5 in the same growing season. The fact that the highest and lowest values are obtained from the same breeding season shows that this feature is more affected by the genetic characteristics of the genotypes than the environment.

Table 7. The averages of the number of capsules in the plant and the number of seeds in the capsule and the resulting groups

GENOTYPES	NUMBER OF CAPSULES PER PLANT			NUMBER OF SEEDS IN CAPSULE		
	2014-2015	2015-2016	AVERAGE	2014-2015	2015-2016	AVERAGE
NK CARAVEL	172.5 hı	344.8 bc	258,6 B	23,0 ab	23,3 ab	23,1 A
SÜZER	152.5 ı-k	245.8 g	199,1 E	18,8 ef	21,3 b-e	20,0 C-E
PR44W29	136.3 k	312.8 e	224,5 D	22,5 ab	21,3 b-e	21,9 AB
EXCALIBUR	153.8 ı-k	401.5 a	277,6 A	19,8 c-f	21,5 b-d	20,6 B-E
CHAMPLAIN	139.8 jk	305.0 ef	222,4 D	21,3 b-e	20,8 b-f	21,0 B-D
CANDIDATE 1 (DK EKSTORM)	160.0 h-j	322.3 de	241,1 C	24,5 a	19,0 d-f	21,8 A-C
CANDIDATE 2 (TK-05-14)	177.8 h	334.8 cd	256,3 BC	18,8 ef	19,0 d-f	18,9 E
CANDIDATE 3 (DK EXPOWER)	138.5 k	365.8 b	252,1 BC	16,0 g	21,8 bc	18,9 E
CANDIDATE 4 (NK LINUS)	137.5 k	286.3 f	211,9 DE	21,5 b-d	18,3 fg	19,9 DE
AVERAGE	152.1 B	324.3 A		20,7	20,7	
LSD 0.05 YEAR		19.22				
LSD 0.05 GENOTYPE		15.19			1.85	
LSD 0.05 YEAR*GENOTYPE		21.49			2.65	

LSD: Low singificant difference

Seed yield (kg ha^{-1})

In terms of seed yields; While a statistically significant difference at the level of 1% was detected between genotypes, the interaction of year and year*genotype was found to be no significant (Table 4). Seed yields of the genotypes varied between 335.6-512.1 kg ha^{-1} (Table 8). The highest grain yield was obtained from the Candidate 4 (NK Linus) and NK Caravel genotypes, and the lowest grain yield was obtained from the Champlain variety. The irregularities in total precipitation and temperature in April, May and June in 2014-2015 growing season and 2015-2016 growing season in Tekirdağ conditions caused changes in seed yield and yield components of genotypes. Therefore, while the average seed yield of the varietys was 4054 kg ha^{-1} in 2014-2015 growing seasons, the average seed yield of the varietys was 4661 kg ha^{-1} in 2015-2016 growing season. In terms of seed yields; Between 2014-2015 and 2015-2016 growing season, the most negative change occurred in Champlain, Süzer, PR44W29 and candidate 2 (Süzer) varietys, the least change occurred in NK Caravel and candidate 1 (DK Ekstrom) varietys. This situation strengthened the judgment that the performance of varietys is mostly affected by the environment.

Oil Ratio (%)

In terms of oil ratio trait; While it was found statistically significant at the level of 1% between years and genotypes, the year*genotype interaction was found to be statistically no significant (Table 4). Depending on the years, the fat ratio was found to be 36.5% to 39.6%. It is possible to say that the higher oil ratio in 2015-16 growing season, when the experiment was conducted, compared to the 2014-15 growing season, is due to the climatic factors of both growing seasons. Especially in the 2015-16 growing season, the low precipitation rate and high temperature of the months in the generative period to generative caused an increase in the oil rate, and it showed that environmental factors in the generative period may have an effect on the oil rate in rapeseed.

Oil ratio of genotypes varied between 36.1-39.9%. The highest oil ratio was obtained from Candidate 1 (DK Ekstorm), and the lowest oil ratio was obtained from Champlain variety. The oil ratio in rapeseed plant may vary depending on the genetic characteristics of the genotypes.

Table 8. Averages and groups of grain yield and oil Ratio characteristics

GENOTYPES	SEED YIELD (KG HA^{-1})			OIL RATIO (%)		
	2014-2015	2015-2016	AVERAGE	2014-2015	2015-2016	AVERAGE
NK CARAVEL	5024	5042	5033 A	37.4	40,8	39,1 AB
SÜZER	3425	4452	3938 C	36.0	41,1	38,6 BC
PR44W29	3896	4928	4412 B	35.2	38,9	37,1 DE
EXCALIBUR	3978	4394	4186 BC	36.8	40,0	38,4 BC
CHAMPLAIN	2854	3859	3356 D	34.9	37,4	36,1 E
CANDIDATE 1 (DK EKSTORM)	4290	4444	4367 BC	39.0	40,9	39,9 A
CANDIDATE 2 (TK-05-14)	3878	4907	4392BC	36.3	38,2	37,3 D
CANDIDATE 3 (DK EXPOWER)	4257	4571	4414 BC	36.2	39,1	37,6 CD
CANDIDATE 4 (NK LINUS)	4887	5356	5121 A	37.2	40,3	38,7 B
AVERAGE	4054	4661		36.5 B	39,6 A	
LSD 0.05 YEAR					0.33	
LSD 0.05 GENOTYPE		47.05			0.99	
LSD 0.05 YEAR*GENOTYPE						

LSD: Low singificant difference

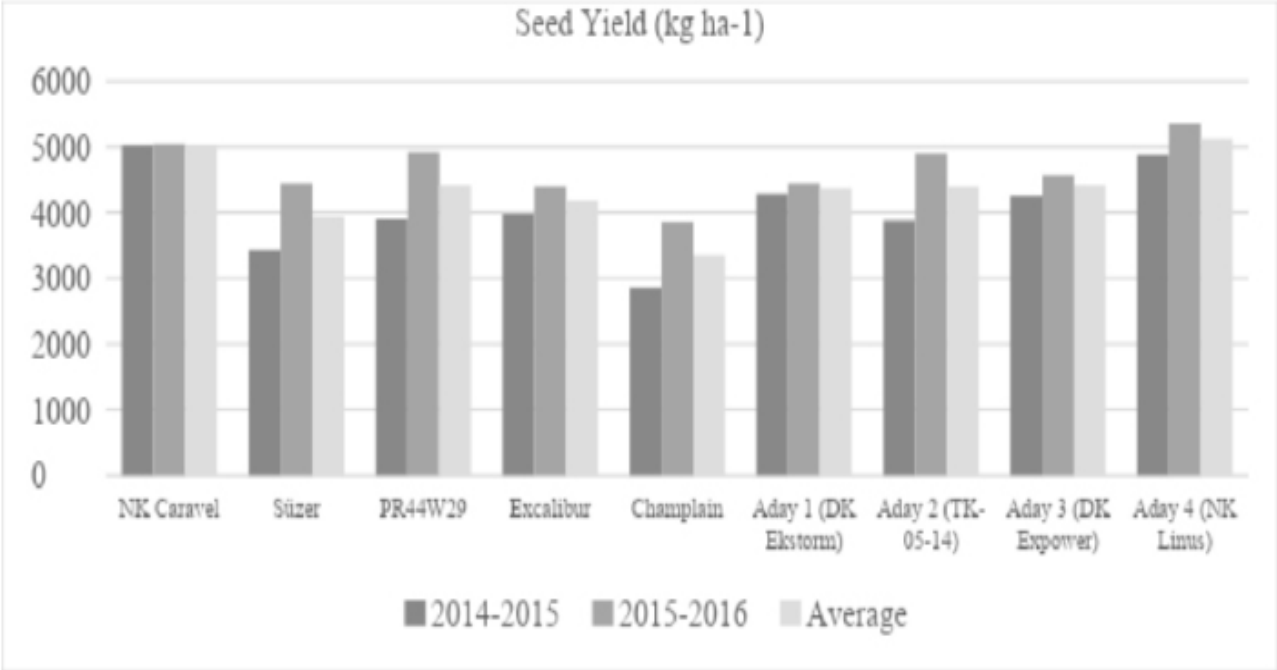

Figure 1. Seed yields and averages of varieties depending on years

Many researchers have actually revealed that seed yield is more affected by the environment. In their studies in different genotypes and locations, Başalma (1997) seed yield; 2773-3193 kg ha^{-1}, Öztürk (2000) 3095-3517 kg ha^{-1}, Başalma and Kolsarıcı, (2001) 1743-1990 kg ha^{-1}, Baydar (2005), 2180-2872 kg ha^{-1}, Gizlenci et al., (2007) 1306-2273 kg ha^{-1}, Karaaslan et al., (2007) 1773-2856 kg ha^{-1}, Akınerdem et al., (2009) 1943-3208 kg ha^{-1}, Sargın (2012) 1801-3040 kg ha^{-1}, Coşkun and Öztürk (2014) 3945-6348 kg ha^{-1}, Begna and Angadi (2016) 1438-2838 kg ha^{-1}, Süzer (2016) 2860-3503 kg ha^{-1}, Dolgun et al., (2019) 3142-5055 kg ha^{-1}, Soysal and Bayram (2022) reported that it varies between 2563-3818 kg ha^{-1}. Escobar et al., (2011) stated in their study on rapeseed that 74.5% of the variation was explained in terms of seed yield, 45.8% of this variation was affected by the genotype and 28.7% by the environment. Moghaddam and Pourdad (2011) reported that the number of first flowering days, the physiological maturity number of day, the plant height, the number of capsules in the plant, the number of seeds in the capsule, the seed yield and the oil ratio are important at the 1% level in their study on rapeseed.

They reported that genotype and genotype*environment interaction is important in terms of seed yield in rapeseed (Shafii et al. 1992; Ali et al. 2003; Marjanovic-Jeromela et al. 2011; Mashayekh et al., 2014; Rahnejat et al., 2015; Sharma and Sardana 2016; Lima et al. 2017; Secchi et al. 2022). Varieties that adapt more easily to climatic conditions and show higher seed and oil yield performance are more preferred by producers in different regions in genotype*environment interaction studies in rapeseed cultivation. For this reason, it is extremely important that the seed yield of the desired genotypes does not fluctuate much under different environmental conditions. However, if this interaction does not change the yield order of genotypes in different environments, there is no problem in terms of cultivar proposal (Atakış and Kaya, 2002).

Table 9. Correlation values of the bilateral relations between the examined traits

EXAMINED TRAITS	SEED YIELD	FIRST FLOWE-RING DAY	PHYSIO-LOGICAL MATURITY NUMBER OF DAY	PLANT HEIGHT	NUMBER OF BRAN-CHES	CAPSULE NUM-BER PER PLANT	NUMBER OF SEEDS IN THE CAPSULE
VERIM							
İLK ÇIÇEKLENME GÜN SAYISI	0.2852*						
FIZYOLOJIK OLUM GÜN SAYISI	0.1986	0.7647**					
BITKI BOYU	0.0765	0.4893**	0.4825**				
YAN DAL SAYISI	0.0664	0.2708*	0.2874*	0.083			
BITKIDEKI KAPSÜL SAYISI	0.3765**	0.7246**	0.808**	0.4903**	0.5361**		
KAPSÜLDE TANE SAYISI	-0.0142	0.1289	0.0055	-0.2589	0.0652	0.0066	
YAĞ ORANI	0.4817**	0.554**	0.5819**	0.3256**	0.3356**	0.676**	0.1168**

**:%1; *: %5 düzeyinde istatistiki olarak önemli

According to Table 9, there is a statistically significant and positive correlation at the 1% level between the seed yield and the number of capsules in the plant (r=0.3765**) and the oil ratio (r=0.4817**); It was determined that there was a statistically significant and positive relationship at the 5% level between the number of first flowering day (r=0.2852*).

The difference between the number of days of first flowering and Physiological maturity number of day (r=0.7647), plant height (r=0.4893), oil ratio (r=0.5819) was significant and positive at the 1% level, the number of branches (r=0.2708) was significant and positive at the 5% level. a relationship was found. Significant and positive at the level of 1% between the number of days to physiological death and plant height (r=0.4825), the number of capsules in the plant (r=0.808) and the oil rate (r=0.5819), between the number of side branches (r=0.2874) at the level of 5% and It was found that there was a positive relationship. It is significant and positive at the level of 1% between the number of days to physiological death and plant height (r=0.4825), the number of capsules in the plant (r=0.808) and the oil rate (r=0.5819), and at the level of 5% and the number of side branches (r=0.2874). positive relationship was found. It was determined that there was a significant and positive relationship at the 1% level between plant height and the number of capsules in the plant (r=0.4903) and the oil ratio (r=0.3256). It was determined that there was a significant and positive relationship at the 1% level between the number of lateral branches and the number of capsules in the plant (r=0.5361) and the oil ratio (r=0.3356). It was observed that there was a significant and positive relationship at the 1% level between the number of capsules in the plant and the oil rate (r=0.676). It was determined that there was a significant and positive relationship at the level of 1% between the number of grains in the capsule and the oil content (r=-0.1168).

While the data obtained in this study were in agreement with some studies, some were different. The main reasons for these differences are thought to be due to different location, climate and soil characteristics, differences in the genetic structures of the cultivars used or different cultivation techniques.

RESULTS

This study; It was carried out in Tekirdağ conditions with 5 rapeseed varieties and 4 rapeseed variety candidates in 2014-2015 and 2015-2016 growimg season. According to the results of the analysis, NK Caravel, candidate 1 (DK Ekstorm), candidate 3 (DK Expower) and candidate 4 (NK Linus) varieties came to the fore. The best results in terms of seed yield and yield components were obtained from NK Caravel, candidate 4 (NK Linus) and PR44W29 varietys. As a result; Year, genotype and year*genotype interactions were examined in terms of seed yield and yield components of varietys in rapeseed cultivation, and it was concluded that NK Caravel, candidate 4 (NK Linus) and PR44W29 cultivars showed high performance under Tekirdag conditions and that these varietys and variety candidates could be recommended in Tekirdag conditions in future studies.

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