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DETERMINATION OF YIELD AND FATTY ACID CONTENTS OF DIFFERENT CAMELINA (*Camelina sativa* L. Crantz) GENOTYPES

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ABSTRACT

Grain yield and fatty acid components of camelina (*Camelina sativa* L. Crantz) are largely unknown in the Eastern Mediterranean. For this reason, a two-year field experiment was carried out with three replicates in Randomized Complete Block Design to determine the yield performances and fatty acid components of 33 camelina genotypes in Mediterranean climate conditions. In the study, in addition to grain yield and agronomic characteristics, oil quality parameters palmitic acid, stearic acid, oleic acid, linoleic acid, and erucic acid were analyzed. It was determined that genotype 28 (3120 kg ha^{-1}) gave good results in terms of yield, followed by genotype 9 (2735 kg ha^{-1}) and 1 (2651 kg ha^{-1}). These genotypes are genetically drought-resistant. Besides, 28 (3.09 %), 9 (2.66 %) and 1 (2.73 %) are the preferred genotypes for the Eastern Mediterranean due to their two-year mean erucic acid content based on the 5% EU residue limit for erucic acid in edible oils. It has been concluded that in regions where the Mediterranean climate prevails and drought stress begins to be seen, camelina cultivation can be done with natural rainfall.

Keywords: Camelina genotypes; Mediterranean climate; grain yield; oil quality; erucic acid

INTRODUCTION

Camelina (*Camelina sativa* L. Crantz) is an annual oil plant from the *Brassicaceae* family (Kurt and Seyis, 2008) and it is tolerant to drought and high temperatures and has greater spring freezing tolerance than canola (Putnam et al., 1993; Angelini et al., 1997; Blackshaw et al., 2011; Yildirim and Onder, 2016; Katar and Katar, 2017). Camelina was first cultivated in the Neolithic Age and was used as an oil plant during the Iron Age, spanning areas from the ancient Roman Empire to the steppes of Southeast Europe and Southwest Asia (Putnam et al. 1993; Subasi et al., 2022). Production of camelina in Europe declined as canola production increased (McWay, 2008). In addition, since Camelina has the potential to be produced with natural rainfall conditions in the winter in the Mediterranean climate zone, it can be considered an oil plant that does not require irrigation or can be grown with very limited irrigation in winter conditions in drought regions. Although the camelina is not selective in terms of soil requirements and has low agricultural requirements, plant yield varies depending on genetic factors, environmental conditions and responses to agricultural practices (Zahuski et al., 2020). In Mediterranean climate conditions, polyunsaturated fatty acid production and α-linolenic acid content increase due to warmer weather during autumn planting and seed filling in the plant. In addition, the dry and hot weather condition that occurs during the seed development period negatively affects the enzymes and greatly affect the oil content. In cultivation whose product pattern is based on cereals, crop diversity can be achieved by sowing camelina in winter and yield increases are observed with the increase in biomass and seed weight. It is also important in mitigating the effects of drought conditions or low rainfall conditions (Zahuski et al., 2020; Angelini et al., 2020).

Camelina seeds are processed into edible oil with a high content of omega-3 fatty acids, as well as into high-protein feed for cattle, fish, poultry, and pigs. Camelina also has numerous industrial applications, including in the production of biofuels and bioproducts such as bioplastics for packaging (Zahuski et al., 2020). While the seeds of summer camelina varieties contain 42% oil, this rate can reach 45% in winter varieties (Kurt and Seyis, 2008). Karvonen et al. (2002) reported that camelina oil (*Camelina sativa*–derived oil) is a good source of α-linolenic acid compared to other edible oils. Altogether 36% to 40% of its fatty acid content consists of α-linolenic acid, an n-3 fatty acid of plant origin. Protein and cellulose are among the important chemical quality criteria of camelina seed. The crude protein in camelina

seeds varies between 18-22% and the crude cellulose ratio varies between 11-15%. Camelina seed contains high vitamin E (25.8-28.2 mg/100 g), making it a strong source of antioxidants (Reenberg, 1994). Camelina breeding studies started at the beginning of the 21st century and considering the significant differences in terms of seed yield and yield-related characteristics, there is a significant potential for the development of camelina through breeding studies (Zahuski, 2020). In recent years, the suitability of camelina varieties with an erucic acid content of less than 1% for human nutrition has been proven in laboratory tests (Toncea et al., 2013). However, there is only one registered camelina variety (Arslanbey) in Turkey and this variety was obtained by selection method under the climate conditions of Central Anatolia (Ankara ecological conditions), where cold winter conditions prevail. It has been reported that the average grain yield is 2350 kg ha^{-1} of this genotype (Katar, 2013). Therefore, although camelina cultivation will be carried out in different geographies, there is no chance of choosing a higher-performing variety in coastal areas close to the Mediterranean. This situation may limit the efficiency (Sevilmis et al., 2019) and camelina increases the biological diversity of arable land. This requires evaluating a diverse group of camelina genotypes for adaptability, production, and oil quality. Identification of well-adapted and high-yielding camelina genotypes will help increase the genetic diversity of Camelina (Zahuski, 2020). However, such studies are lacking in the region. Therefore, this study was conducted on camelina genotypes of diverse origins and morphology for adaptability, seed yield, and fatty acid contents under Mediterranean climate conditions.

MATERIALS AND METHODS

The 33 camelina genotypes, used in this study, were obtained from the gene bank of the United States Department of Agriculture (USDA) in 2017 (Table 1).

Table 1. Information about the camelina genotypes was obtained from the United States Department of Agriculture (USDA) for use in studying adaptation in Turkey

Genotype	Accession information	Origin	Genotype	Accession information	Origin
1	Ames31231	Georgia	**22**	PI 650147	Sweden
2	Ames31232	Georgia	**23**	PI 650148	Denmark
4	PI 258367	Russia	**24**	PI 650149	Germany
7	PI 304270	Sweden	**25**	PI 650150	Denmark
8	PI 304271	Sweden	**26**	PI 650151	Sweden
9	PI 311735	Poland	**27**	PI 650152	Germany
10	PI 311736	Poland	**28**	PI 650153	Russia
11	PI 597833	Denmark	**29**	PI 650154	Russia
13	PI 633193	Germany	**30**	PI 650155	Poland
14	PI 633194	Germany	**31**	PI 650156	Russia
15	PI 650140	Germany	**35**	PI 650160	Russia
16	PI 650141	USA	**36**	PI 650161	Russia
17	PI 650142	Denmark	**37**	PI 650162	Poland
19	PI 650144	Denmark	**38**	PI 650163	Russia
20	PI 650145	Germany	**40**	PI 650165	Rusya
21	PI 650146	Sweden	**42**	PI 650167	Polonia

Research area soil properties

The research was carried out at Ege University, Faculty of Agriculture, experimental area in Izmir 2019-2020 and 2020-2021. Although the altitude of the field is 10 m, the experimental area has a heavy soil structure with clay-silt soil at 0-20 cm depth and clay-loamy structure at 20-40 cm depth (Ilker, 2017).

Climate characteristics of the research area

Long-term climate data for the test site was given in Table 2, and climate data during the growing period of camelina was given in Table 3.

Table 2. Climate data for Bornova location based on long-term average (2013-2022)

Parameter	November	December	January	February	March	April	May
Monthly Min. Temperature (°C)	1.8	-2.2	-4.7	-2.0	-1.9	2.6	8.5
Monthly Average Temperature (°C)	14.9	10.4	8.9	11.0	12.9	17.1	22.1
Monthly Max. Temperature (°C)	28.9	23.9	23.8	27.5	28.0	33.0	39.0
Monthly Average Relative Humidity (%)	66.6	68.8	67.0	65.9	64.2	61.7	56.1
Monthly Total Precipitation Average (mm)	60.06	79.92	**153.62**	95.14	65.50	35.89	36.83

Table 3. Climate Data during the growing period of camelina for Bornova in 2019, 2020 and 2021.

Parameter	Year/Month	November	December	January	February	March	April	May
Monthly Average Temperature (°C)	2019	16.9	11.3	8.7	9.8	13.2	16.3	21.9
	2020	14.3	12.4	8.3	10.8	13.5	16.4	21.6
	2021	15.6	11.2	10.6	11.1	11.1	16.7	22.9
Monthly Total Precipitation Average (mm)	2019	58.2	73.4	369.3	106.3	37.8	66.1	12.6
	2020	2.2	126.0	37.5	76.6	83.0	56.1	55.2
	2021	51.9	178.3	213.5	138.0	98.0	25.4	0.6

Sowing, Maintenance and Harvest

Seeds were sown manually in November 2019 and November 2020 in 3 m long, 3-row plots. The rows are 20 cm apart and the seed is 10 cm apart down the row with 3 replications, according to the Randomized Complete Block Design. After plant emergence was observed, thinning was carried out to 93 maintained plants in each plot.

Over the years, fertilizer (15-15-15 NPK) was applied at 100 kg per hectare, as basal dose at sowing into the soil whereas 100 kg of urea fertilizer (46%) per hectare was applied as topdress fertilizer. Weeds were controlled twice (March-May) manually and with a hoeing machine between rows. Pesticides were not applied during the experiment. Since there was not enough rain, sprinkler irrigation was applied after the planting process and the emergence took place. After this stage, the irrigation water needed by the plant during the vegetative growth period was provided by natural rainfall conditions. Plants reaching maturity were harvested by hand from the soil surface.

Morphological and yield-related traits

Harvesting was done manually in June 2020 and 2021, waiting for all genotypes to mature. Plant height, first lateral branch height, and number of capsules per plant were measured on five randomly selected plants representing each plot. The average of the measurements was calculated and documented for each genotype.

The number of seeds in 10 randomly selected capsules representing each plot was measured and calculated and their averages were taken. Threshing was carried out after harvest. The number of seeds in the capsule was recorded. Then, seed samples were taken in five replications for thousand-grain weight, thousand grains were counted and their weights were measured on a precision scale. Grain yield was obtained by harvesting the plants in the plot at three replications and then converted to kg ha^{-1}.

Fatty acids (%)

The percentages of fatty acids in Camelina oils were determined by using gas chromatography. Samples, ground to approximately 30-50 g, were placed into Erlenmeyer flasks and covered with 100-150 ml of hexane, a lipid solvent. The flasks were then sealed with cotton and shaken in a shaker at a medium speed (~200 rpm) for 12 hours. After this process, the oil in the samples forms a solution with hexane, which is then filtered into a beaker using glass wool. The solvent was then removed from the solution to obtain raw oil (Basoglu, 1986; Koyuncu, 1996). Before fatty acid analysis, esterification was applied to the raw oil samples (Anonymous, 2000). In this process, 0.5 g of raw oil sample was placed into a 50 ml Falcon tube, and then 1 ml of 2 N methanolic KOH solution and 7 ml of n-hexane were added. The mixture was centrifuged at 4500 rpm for 30 minutes to clarify the upper phase. The upper phase containing fatty acid methyl esters was transferred into special glass bottles for injection into gas chromatography. Using an automatic sampling apparatus, 1 µl of samples was automatically taken and injected into the device. A capillary column (60 m x 0.25 mm i.d., 0.20 µm film thickness) was used for determining the oil composition. During the analysis, peaks were identified by calculating the peak's time and area, and the results were given as percentages of fatty acids. Based on the observed peaks, the amounts of palmitic acid (C16:0), stearic acid (C18:0), oleic acid (C18:1), linoleic acid (C18:2), alpha-linolenic acid (ALA) (C18:3), and erucic acid (C22:1) contained in Camelina oil were determined as percentages (%).

Statistical analysis

In terms of the examined characteristics, a combined analysis of variance over the years was performed to determine whether there was a difference between the general averages of each genotype and application years, and the average values between genotypes and years were compared according to the LSD test (Steel and Torrie, 1960). Variance analyses and LSD tests were performed with the TOTEMSTAT package program (Acikgoz et al., 2004).

RESULTS

Grain Yield (kg ha^{-1})

Except for plant height, the year × genotype interaction was statistically important. The yield performances of genotypes varied under climatic conditions in different growing seasons (Table 4). This was probably due to climatic conditions that varied from year to year.

Table 4. Results of combined analyses of variance over two years for the morphological characteristics of camelina genotypes.

		Mean Square Values					
Sources of Variation	**DF**	**Yield**	**Plant height**	**First lateral branch height**	**No. of capsules per plant**	**No. of seeds per capsule**	**Thousand-grain weight**
Year (A)	1	103732.4 **	2081.6 **	5699.4 **	143194.0 **	29.8 ns	0.139 **
Error 1	4	4236.2	10.5	53.8	2711.4	10.7	0.003
Genotype (B)	32	11686.8 **	537.4 **	282.3 **	10674.0 **	13.3 **	0.203 **
Year × Genotype (A × B)	32	1856.5 **	105.3 ns	169.9 **	3644.0 **	3.44 **	0.030 **
Error	128	993.5	86.8	16.1	553.7	1.32	0.005

* and ** indicate significance at 0.05 and 0.01 levels of probability, respectively. ns; not significant

The highest grain yield among camelina genotypes in both years was obtained from genotype 28 originating from Russia (3120 kg ha^{-1}). This was followed by genotype 9 originating from Poland and number 1 originating from Georgia (2735 kg ha^{-1} and 2651 kg ha^{-1} respectively) (Table 5). The average yield in 2021 was 1288 kg ha^{-1}. Genotypes 27, 10, 35, and 43 were among the five genotypes that showed the lowest seed yield performance in both years. Although ecological factors resulting from the difference in harvest years cause some decrease in seed yields, these genotypes maintained their high yield potential compared to other genotypes. Besides, in the 2021 growing season, which is the second year of the experiment, the mean grain yield of 2021 decreased in all genotypes due to less rainfall in April and almost no rainfall in May. Despite this, genotypes 28 and 9, which were determined as high yield in 2020, showed the highest performance in terms of grain yield in 2021, when water stress occurred. Therefore, it can be inferred that these genotypes have a strong genetic structure in terms of grain yield in Mediterranean climate coastline water stress conditions.

Table 5. Mean grain yields and plant height for 2020-2021.

Grain Yield (kg ha^{-1})					**Plant Height (cm)**				
2020		**2021**		**Two years**	**2020**		**2021**		**Two years**
Genotype No	**G. Yield**	**Genotype No**	**G. Yield**	**Mean**	**Genotype No**	**P. height**	**Genotype No**	**P. height**	**Mean**
1	**2651 AB**	**1**	**1921 AB**	**2286**	**1**	76.9	**1**	77.4	77.1 A-F
2	1780 D-H	**2**	1675 A-D	1727	**2**	87.4	**2**	87.4	**87.4 A**
4	1418 G-K	**4**	1330 C-I	1374	**4**	80.5	**4**	86.6	83.5 A-E
7	1647 E-H	**7**	944 H-L	1295	**7**	69.3	**7**	67.9	68.6 FG
8	2262 BCD	**8**	1426 B-H	1844	**8**	78.8	**8**	84.9	81.8 A-E
9	**2735 AB**	**9**	**2018 A**	**2376**	**9**	69.1	**9**	80.9	75.0 C-F
10	613 M	**10**	556 KL	584	**10**	31.5	**10**	41.1	36.3 H
11	2061 C-F	**11**	1573 A-G	1817	**11**	81.3	**11**	78.9	80.1 A-E
13	1876 C-G	**13**	1142 E-J	1509	**13**	57.9	**13**	80.6	69.2 FG
14	1696 E-H	**14**	1287 C-I	1491	**14**	85.5	**14**	81.8	83.6 A-E
15	1337 H-K	**15**	1136 E-J	1236	**15**	65.7	**15**	84.1	74.9 C-F
16	1484 G-K	**16**	1338 C-I	1411	**16**	72.0	**16**	80.9	76.4 B-F
17	2319 BC	**17**	1355 C-I	1837	**17**	79.1	**17**	73.7	76.4 B-F
19	2011 C-F	**19**	1761 ABC	1886	**19**	84.1	**19**	84.1	84.1 A-E
20	2015 C-F	**20**	1635 A-E	1825	**20**	69.1	**20**	80.4	74.7 C-F
21	1774 E-H	**21**	1178 D-J	1476	**21**	64.7	**21**	84.0	74.3 D-F
22	1870 C-G	**22**	1793 ABC	1831	**22**	69.6	**22**	85.3	77.4 A-F
23	1599 F-I	**23**	1057 H-K	1328	**23**	80.2	**23**	74.1	77.1 A-F
24	1356 H-K	**24**	1212 D-I	1284	**24**	71.3	**24**	90.7	81.0 A-E
25	1677 E-H	**25**	1431 B-H	1554	**25**	82.5	**25**	86.9	84.7 A-D
26	1074 JKL	**26**	1232 D-I	1153	**26**	81.6	**26**	79.0	80.3 A-E
27	464 M	**27**	670 JKL	567	**27**	84.9	**27**	85.9	85.4 A-C
28	**3120 A**	**28**	**2040 A**	**2580**	**28**	65.0	**28**	82.5	73.7 EF
29	1906 C-G	**29**	966 H-L	1436	**29**	83.7	**29**	88.4	**86.0 AB**
30	1830 D-H	**30**	1062 G-K	1446	**30**	83.9	**30**	85.6	84.7 A-D
31	1628 E-I	**31**	1321 C-I	1474	**31**	82.3	**31**	92.4	**87.3 A**
35	988 KL	**35**	861 I-L	924	**35**	76.6	**35**	80.2	78.4 A-F
36	2137 CDE	**36**	1219 D-I	1678	**36**	71.1	**36**	86.9	79.0 A-F
37	1922 C-G	**37**	1205 D-I	1563	**37**	79.2	**37**	87.7	83.4 A-E
38	1572 F-J	**38**	1122 F-J	1347	**38**	76.3	**38**	86.4	81.3 A-E
40	1893 C-G	**40**	926 H-L	1409	**40**	78.1	**40**	91.4	84.7 A-D
42	1747 E-H	**42**	1593 A-F	1670	**42**	80.7	**42**	84.9	82.8 A-E
43	1134 IJK	**43**	506 L	820	**43**	66.3	**43**	56.9	61.6 G
Mean	1745		1288	1516	**Mean**	74.7		81.2	77.9
LSD: 51.12					LSD: 10.68				

Plant height (cm)

In terms of plant height, the year × genotype interaction was insignificant, that is, the plant height performances of genotypes did not differ under climatic conditions in different growing seasons (Table 4). Genotype 2 originating from Georgia (87.4 cm) and genotype 31 originating from Russia (87.3 cm) showed the highest average plant height in camelina. These genotypes were followed by genotype 29 (86.0 cm) originating from Russia, which is in the EU group. The lowest average plant height was obtained from genotype number 10 (36.3 cm), originating from Poland (Table 5). This is due to the difference in genotype characteristics.

First lateral branch height (cm)

The year × genotype interaction was significant for the first lateral branch height (Table 4). This feature is very important in camelina plants, as in many cultivated plants. The lower the first lateral branch height in plants that are machine-harvested, the greater the risk of seed loss during the harvest of the plant. In the first year, the highest first lateral branch height was shown by genotype 26 (55.7 cm) originating from Sweden, and genotype 14 (55.1 cm) from Germany, and these genotypes were followed by genotype 25 from Denmark in the EU group. The average first lateral branch height was found to be 35.7 cm. When the first lateral branch height of 2021 is examined, genotype 23 (64.2 cm) ranks first, followed by genotype 29 (57.0 cm) in group B. In the second year, the first lateral branch height was found to be 46.1 cm. Genotype 10 showed the lowest first lateral branch height in both years. At the same time, this genotype has the lowest plant height, and due to this property, it is the last genotype that can be preferred in terms of suitability for machine harvesting. Plant height and first lateral branch height do not interact with each other. Although genotypes 26 and 23 showed the highest first lateral branch height performance in 2020 and 2021, their plant heights were close to the average and they were not among the genotypes with the highest plant height (Table 6).

Table 6. First lateral branch height (cm) and number of capsules per plant data for 2020-2021.

First lateral branch height (cm)					**No. of capsules per plant**				
2020		**2021**		**Two years**	**2020**		**2021**		**Two years**
Genotype No	**First lateral branch height (cm)**	**Genotype No**	**First lateral branch height (cm)**	**Mean (cm)**	**Genotype No**	**No. of capsules per plant**	**Genotype No**	**No. of capsules per plant**	**Mean**
1	36.6 F-I	**1**	33.0 J	34.80	**1**	**296.2 A**	**1**	**184.6 A**	240.40
2	47.7 BC	**2**	47.7 D-H	47.70	**2**	185.4 D-G	**2**	**182.0 A**	183.70
4	34.7 G-J	**4**	43.4 G-I	39.00	**4**	134.4 I-K	**4**	139.0 B-G	136.70
7	30.8 I-L	**7**	34.3 J	32.50	**7**	233.8 B	**7**	98.8 H-J	166.30
8	42.4 C-F	**8**	49.4 C-G	45.90	**8**	231.9 B	**8**	146.6 A-F	189.25
9	32.1 I-K	**9**	42.0 HI	37.05	**9**	240.9 B	**9**	152.2 A-E	196.55
10	17.4 N	**10**	19.3 K	18.35	**10**	59.7 M	**10**	62.5 JK	61.10
11	46.4 CD	**11**	44.6 E-I	45.50	**11**	228.2 BC	**11**	158.0 A-C	193.10
13	22.1 MN	**13**	50.3 C-F	36.20	**13**	188.1 D-G	**13**	117.0 D-H	152.55
14	**55.1 A**	**14**	46.2 D-I	50.65	**14**	193.4 C-F	**14**	116.0 E-H	154.70
15	43.8 C-E	**15**	50.5 C-F	47.15	**15**	147.1 E-J	**15**	130.1 B-H	138.60
16	36.4 F-J	**16**	45.6 E-I	41.00	**16**	208.2 B-E	**16**	131.4 B-H	169.80
17	39.4 E-H	**17**	49.8 C-G	44.60	**17**	**246.0 B**	**17**	122.6 C-H	184.30
19	41.2 D-G	**19**	41.2 I	41.20	**19**	167.6 F-I	**19**	161.8 AB	164.70
20	25.3 LM	**20**	48.7 D-G	37.00	**20**	241.4 B	**20**	**164.2 AB**	202.80
21	32.6 I-K	**21**	48.3 D-H	40.45	**21**	166.8 F-I	**21**	116.4 D-H	141.60
22	43.7 C-E	**22**	47.0 D-I	45.35	**22**	110.0 J-L	**22**	122.9 C-H	116.45
23	30.5 I-L	**23**	**64.2 A**	47.35	**23**	136.1 H-K	**23**	132.2 B-H	134.15
24	34.8 G-J	**24**	55.3 BC	45.05	**24**	172.3 E-I	**24**	158.5 A-C	165.40
25	**54.0 AB**	**25**	50.8 B-E	52.40	**25**	111.9 J-L	**25**	100.9 G-I	106.40
26	**55.7 A**	**26**	46.9 DI	51.30	**26**	67.4 M	**26**	104.9 G-I	86.15
27	26.8 K-M	**27**	52.5 B-D	39.65	**27**	106.0 KL	**27**	114.0 F-H	110
28	28.1 LM	**28**	41.1 I	34.60	**28**	**288.8 A**	**28**	162.1 AB	225.45
29	39.2 E-H	**29**	**57.0 B**	48.10	**29**	213.6 B-D	**29**	107.0 G-I	160.30
30	33.3 H-K	**30**	55.4 BC	44.35	**30**	236.9 B	**30**	112.0 F-H	174.45
31	35.0 G-J	**31**	55.8 BC	45.40	**31**	153.6 G-I	**31**	136.6 C-H	145.10
35	30.0 J-L	**35**	45.2 E-I	37.60	**35**	89.4 LM	**35**	71.2 I-K	80.30
36	35.0 G-J	**36**	48.1 D-H	41.55	**36**	229.3 BC	**36**	148.4 A-F	188.85
37	32.2 I-K	**37**	46.3 D-I	39.25	**37**	174.0 E-H	**37**	135.0 B-H	154.50
38	32.2 I-K	**38**	44.2 F-I	38.20	**38**	159.0 F-I	**38**	122.5 C-H	140.75
40	30.2 I-L	**40**	44.7 E-I	37.45	**40**	239.0 B	**40**	111.2 F-H	175.10
42	25.2 LM	**42**	48.4 D-H	36.80	**42**	232.5 B	**42**	154.3 A-D	193.40
43	27.4 K-M	**43**	34.2 J	30.80	**43**	110.3 J-L	**43**	46.8 K	78.55
LSD: 6.51					LSD: 38.1				

No. of capsules per plant

One of the most important characteristics affecting yield is the number of capsules (fruits) in the plant. In the camelina, the fruit is in capsule form (Karayel et al., 2021). It was determined that the year × genotype interaction is important. This interaction between

genotype and environment, particularly due to water stress experienced in the second year, may have led to differentiation in the adaptation abilities of genotypes to adverse conditions (Table 4). In 2020, the highest number of capsules was obtained from genotypes 1 (296 capsules/plant) and 28 (289 capsules/plant). These genotypes were followed by genotype number 17. In the 2nd year of the experiment, genotypes 1 and 2 showed the highest capsule number performance, followed by genotype 20. In the second year of the experiment, genotypes 1 and 28 gave statistically the highest number of capsules. It was determined that these were followed by genotype number 20. The lowest number of capsules in 2020 was observed in genotypes 10, 26, and 35. The number of capsules directly affects the yield. Genotypes 10 and 35, which show the lowest number of capsules, are among the genotypes with the lowest grain yield in terms of grain yield performance. In addition, the fact that genotypes 1 and 28 maintained their superiority in terms of the number of capsules in the plant and grain yield even under poor environmental conditions, although the number of capsules in the plant decreased in the second harvest year, proves this idea (Table 6).

No. of seeds per capsule

One of the important properties affecting the yield is the number of grains in the capsule (Sevilmis and Bilgili, 2019). It has been determined that the year × genotype interaction is important, that is, the performance of genotypes in the number of grains in the capsule varies under climatic conditions in different growing seasons (Table 4). In 2020, the highest number of grains in the capsule was obtained from genotype no. 19 (14.4) and this genotype was followed by genotype no. 35, from Russia, and genotype no. 22, originating from Sweden. In 2021, genotype no. 35 (15.4) exhibited the highest grain number performance in the capsule, and this genotype was followed by genotypes no. 14 and 16. Although the number of grains in the capsule is important among the yield components, it is not sufficient on its own. For example, although genotype 35, originating from Russia, is one of the three highest-performing genotypes in both years in terms of the number of grains in the capsule, it is seen to be in the background when evaluated in terms of yield (Table 7).

Table 7. Number of seeds per capsule and thousand-grain weight (g) data for 2020-2021.

No. of seeds per capsule					**Thousand grain weight (g)**				
2020		**2021**		**Two years**	**2020**		**2021**		**Two years**
Genotype No	**No. of seeds per capsule**	**Genotype No**	**No. of seeds per capsule**	**Mean**	**Genotype No**	**Thousand grain weight (g)**	**Genotype No**	**Thousand grain weight (g)**	**Mean**
1	9.4 L-O	**1**	11.3 F-L	10.35	**1**	1.07 D-F	**1**	1.04 E-H	1.06
2	12.3 B-F	**2**	12.2 C-I	12.25	**2**	0.87 I-M	**2**	0.84 J-L	0.86
4	12.4 B-E	**4**	11.3 F-L	11.85	**4**	0.95 G-K	**4**	0.94 G-J	0.95
7	8.9 M-O	**7**	11.6 F-K	10.25	**7**	0.88 I-M	**7**	0.93 H-J	0.91
8	10.5 F-N	**8**	10.8 H-M	10.65	**8**	1.04 E-H	**8**	1.02 F-H	1.03
9	10.6 E-M	**9**	12.8 B-G	11.70	**9**	1.19 C	**9**	1.16 B-D	1.18
10	10.7 D-M	**10**	9.6 L-N	10.15	**10**	1.08 C-F	**10**	1.02 F-H	1.05
11	11.3 D-J	**11**	13.0 B-F	12.15	**11**	0.89 I-M	**11**	0.84 J-L	0.87
13	11.6 D-I	**13**	11.3 F-L	11.45	**13**	0.98 F-J	**13**	0.95 G-J	0.97
14	11.0 D-L	**14**	14.6 AB	12.80	**14**	0.91 I-M	**14**	0.85 J-L	0.88
15	11.8 C-G	**15**	11.5 F-L	11.65	**15**	0.86 K-M	**15**	0.85 J-L	0.86
16	9.8 I-O	**16**	**14.6 AB**	12.20	**16**	0.81 MN	**16**	0.78 KL	0.80
17	11.7 D-H	**17**	14.0 A-C	12.85	**17**	0.90 I-M	**17**	0.87 I-K	0.89
19	**14.4 A**	**19**	13.8 A-D	14.10	**19**	0.93 H-L	**19**	0.89 I-K	0.91
20	10.3 G-N	**20**	12.0 D-I	11.15	**20**	0.91 I-M	**20**	0.93 H-J	0.92
21	12.6 A-D	**21**	12.7 B-G	12.65	**21**	0.95 G-L	**21**	0.90 I-J	0.93
22	**14.0 AB**	**22**	13.8 A-D	13.90	**22**	**1.37 B**	**22**	1.17 BC	1.27
23	11.1 D-L	**23**	12.0 D-I	11.55	**23**	1.18 CD	**23**	0.75 L	0.97
24	10.6 E-M	**24**	11.0 G-L	10.80	**24**	0.83 L-N	**24**	0.78 KL	0.81
25	9.9 H-N	**25**	13.5 B-E	11.70	**25**	**1.69 A**	**25**	**1.20 B**	1.45
26	10.6 E-N	**26**	9.8 K-N	10.20	**26**	**1.68 A**	**26**	**1.35 A**	1.52
27	9.96 H-N	**27**	10.4 I-N	10.18	**27**	0.50 O	**27**	0.63 M	0.57
28	11.6 D-I	**28**	13.7 A-D	12.65	**28**	1.04 E-H	**28**	1.05 D-G	1.05
29	11.0 D-L	**29**	9.8 K-N	10.40	**29**	0.91 I-M	**29**	1.02 F-H	0.97
30	8.7 N-O	**30**	10.0 J-N	9.35	**30**	0.98 F-I	**30**	1.06 C-F	1.02
31	13.7 A-D	**31**	12.6 C-H	13.15	**31**	0.87 J-M	**31**	0.85 J-L	0.86
35	**14.0 AB**	**35**	**15.4 A**	14.70	**35**	0.88 I-M	**35**	0.90 IJ	0.89
36	9.5 J-O	**36**	8.6 N	9.05	**36**	1.09 C-F	**36**	1.07 C-F	1.08
37	9.4 K-O	**37**	8.7 N	9.05	**37**	1.31 B	**37**	1.15 B_E	1.23
38	10.6 E-N	**38**	10.8 H-M	10.70	**38**	1.05 E-G	**38**	0.94 G-J	1.00
40	8.0 O	**40**	9.0 MN	8.50	**40**	1.11 C-E	**40**	1.06 C-F	1.09
42	11.3 D-K	**42**	11.8 E-J	11.55	**42**	0.74 N	**42**	0.97 F-I	0.86
43	11.7 D-H	**43**	12.3 C-H	12.00	**43**	1.04 E-H	**43**	0.98 F-I	1.01
LSD: 1.87					LSD: 0.115				

Thousand-grain weight (g)

In the study, it was determined that the year × genotype interaction was important, that is, the thousand-grain weight performances of genotypes varied under climatic conditions in different growing seasons (Table 4). With an average thousand-grain weight of 1.01 g, in 2020, the highest thousand-grain weight was obtained from genotypes 25 and 26. These genotypes were followed by genotypes 22 and 37. In 2021, genotype 26 (1.35 g) exhibited the highest thousand grain weight performance. Genotypes 25 and 26 had the highest thousand-grain weight in both harvest years, and differences between the two genotypes were observed against the other 31 genotypes. In the second year, the values of thousand grain weights were lower (Table 7).

Palmitic Acid (C16:0) (%)

In the study, it was determined that the year × genotype interaction was important, that is, the palmitic acid performances of genotypes varied under climatic conditions in different growing seasons (Table 8).

Table 8. Palmitic acid and stearic acid values for 2020-2021

Palmitic acid (%)					Stearic acid (%)				
2020		2021		Two years	2020		2021		Two years
Genotype No	Palmitic acid	Genotype No	Palmitic acid	Mean	Genotype No	Stearic acid	Genotype No	Stearic acid	Mean
1	5.26 M-P	**1**	5.13 P-S	5.20	**1**	2.46 G-I	**1**	2.44 F-I	2.45
2	5.60 D-I	**2**	5.49 H-K	5.55	**2**	2.22 LM	**2**	2.28 JK	2.25
4	5.19 O-P	**4**	5.16 O-S	5.18	**4**	2.13 M	**4**	2.24 KL	2.19
7	5.58 E-I	**7**	5.69 C-G	5.64	**7**	2.33 J-L	**7**	2.31 JK	2.32
8	5.74 C-E	**8**	5.79 B-D	5.77	**8**	2.23 LM	**8**	2.25 KL	2.24
9	5.80 BC	**9**	5.75 B-F	5.78	**9**	2.60 A-E	**9**	2.53 C-F	2.57
10	5.57 F-I	**10**	5.62 D-H	5.60	**10**	2.24 LM	**10**	2.24 KL	2.24
11	5.62 D-H	**11**	5.60 E-H	5.61	**11**	2.48 E-I	**11**	2.45 F-H	2.47
13	5.38 J-M	**13**	5.34 K-N	5.36	**13**	2.29 KL	**13**	2.28 JK	2.29
14	5.50 H-K	**14**	5.51 H-J	5.51	**14**	**2.70 A**	**14**	**2.65 AB**	2.68
15	5.69 C-F	**15**	5.71 B-G	5.70	**15**	2.64 A-D	**15**	2.50 D-G	2.57
16	5.67 C-G	**16**	5.38 J-N	5.53	**16**	2.65 A-C	**16**	2.65 A-C	2.65
17	5.59 E-I	**17**	5.81 BC	5.70	**17**	**2.68 A**	**17**	2.45 F-H	2.57
19	5.36 K-N	**19**	5.23 N-R	5.30	**19**	**2.69 A**	**19**	2.57 A-E	2.63
20	5.21 N-P	**20**	5.27 M-P	5.24	**20**	2.63 A-D	**20**	2.50 D-G	2.57
21	5.45 I-L	**21**	5.42 I-M	5.44	**21**	2.55 C-H	**21**	2.59 A-D	2.57
22	5.33 L-O	**22**	5.28 M-P	5.31	**22**	2.53 D-H	**22**	2.46 E-H	2.50
23	5.14 P	**23**	5.11 P-S	5.13	**23**	2.55 C-G	**23**	2.58 A-D	2.57
24	5.52 G-K	**24**	5.59 F-H	5.56	**24**	2.56 B-G	**24**	2.54 B-F	2.55
25	5.10 PR	**25**	5.03 S	5.07	**25**	2.40 I-K	**25**	2.34 H-K	2.37
26	5.37 J-N	**26**	5.35 J-N	5.36	**26**	**2.67 AB**	**26**	2.55 B-F	2.61
27	**6.00 A**	**27**	**6.10 A**	6.05	**27**	2.31 KL	**27**	2.27 JK	2.29
28	5.76 CD	**28**	5.80 BC	5.78	**28**	2.31 KL	**28**	2.33 I-K	2.32
29	5.57 F-I	**29**	5.32 L-O	5.45	**29**	2.43 H-J	**29**	**2.67 A**	2.55
30	5.57 F-I	**30**	5.60 E-H	5.59	**30**	2.55 C-H	**30**	2.52 D-F	2.54
31	5.84 A-C	**31**	5.07 RS	5.46	**31**	2.53 D-H	**31**	2.14 L	2.34
35	5.54 F-J	**35**	**5.86 B**	5.70	**35**	2.48 F-I	**35**	2.50 D-G	2.49
36	4.94 RS	**36**	5.16 O-S	5.05	**36**	2.64 A-D	**36**	2.64 A-C	2.64
37	4.93 S	**37**	5.22 N-R	5.08	**37**	2.26 L	**37**	2.30 JK	2.28
38	5.52 G-K	**38**	5.46 G-K	5.49	**38**	2.43 H-J	**38**	2.39 G-J	2.41
40	5.62 D-H	**40**	5.62 E-H	5.62	**40**	2.27 L	**40**	2.24 KL	2.26
42	**5.95 AB**	**42**	5.76 B-E	5.86	**42**	2.59 A-F	**42**	2.60 A-D	2.60
43	5.50 H-K	**43**	5.57 G-I	5.54	**43**	2.29 KL	**43**	2.26 K	2.28
LSD: 0.166					LSD: 0.119				

In both years of the experiment, the highest palmitic acid value belonged to genotype 27 originating from Germany. The genotypes with the lowest palmitic acid content in the first year are genotypes 37 and 36. In the second year, genotypes 25 and 31 occurred (Table 8).

Stearic Acid (C18:0) (%)

It has been determined that the year × genotype interaction is important, that is, the stearic acid performances of genotypes vary under climatic conditions in different growing seasons (Table 11). The stearic acid content obtained from camelina genotypes was 2.46% on average in the first year, and the highest palmitic acid values were obtained from genotypes 14, 19, and 17. It is clearly understood that genotypes 14, 16, and 36 are the genotypes with the highest and similar stearic acid values in both harvest years, regardless of ecological factors. Similarly, it was observed in many genotypes such as genotypes 4, 8, and 10 in terms of low stearic acid value. Therefore, it is thought that stearic acid content is

independent of ecological conditions and may be a genotypic property (Table 8).

Oleic Acid (C18:1) (%)

It was determined that the year × genotype interaction is important, that is, the oleic acid performances of genotypes vary under climatic conditions in different growing seasons (Table 11). The average oleic acid value in the first year is 15.41%, and the highest oleic acid value belongs to genotype 16 (17.87%). Genotype 16 was followed by genotypes 35 (16.92%) and 42 (16.88%). In the second year, genotype 16 (18.91%) was observed as the genotype containing the highest oleic acid value. Genotype 16 was followed by genotype 42 (16.94%). In line with the findings, it was observed that genotype 16 was the genotype with the highest oleic acid content in both harvest years, regardless of ecological factors, and was visibly separated from other accessions (Table 9). In the second year of the experiment, due to the lack of expected rainfall in April and May, increases in oleic acid percentages were detected in these three genotypes (16, 35, 42) and other genotypes in the second year.

Table 9. Oleic acid and linoleic acid values in 2020-2021 (%).

Oleic acid (%)					Linoleic acid (%)				
2020		2021		Two years	2020		2021		Two years
Genotype No	Oleic acid	Genotype No	Oleic acid	Mean	Genotype No	Linoleic acid (%)	Genotype No	Linoleic acid (%)	Mean
1	14.68 K-O	**1**	16.19 CD	15.44	**1**	17.41 G-I	**1**	17.80 I-J	17.61
2	15.08 I-M	**2**	15.03 G-J	15.06	**2**	17.10 I-K	**2**	17.12 K-L	17.11
4	14.96 I-M	**4**	15.04 G-J	15.00	**4**	**19.45 B**	**4**	19.37 C	19.41
7	16.04 D-G	**7**	15.63 D-G	15.84	**7**	16.93 I-L	**7**	17.00 KL	16.97
8	14.93 I-M	**8**	14.92 H-L	14.93	**8**	16.82 J-M	**8**	16.75 LM	16.79
9	14.04 OP	**9**	14.26 L-N	14.15	**9**	**20.49 A**	**9**	**20.94 A**	20.72
10	14.82 J-N	**10**	14.79 I-M	14.81	**10**	18.30 D-F	**10**	18.14 G-I	18.22
11	15.52 G-I	**11**	15.36 E-I	15.44	**11**	17.79 F-H	**11**	17.81 IJ	17.80
13	15.45 G-J	**13**	15.47 E-H	15.46	**13**	16.73 K-M	**13**	16.81 LM	16.77
14	16.43 B-E	**14**	16.47 BC	16.45	**14**	17.87 E-G	**14**	18.17 F-I	18.02
15	16.25 B-F	**15**	15.45 E-I	15.85	**15**	17.33 G-J	**15**	18.39 E-H	17.86
16	**17.87 A**	**16**	**18.91 A**	18.39	**16**	16.43 L-N	**16**	16.31 M-N	16.37
17	15.56 G-I	**17**	14.92 H-L	15.24	**17**	17.24 I-K	**17**	17.90 H-J	17.57
19	16.10 C-G	**19**	16.59 B-C	16.35	**19**	16.90 I-L	**19**	16.66 LM	16.78
20	16.34 B_E	**20**	16.44 BC	16.39	**20**	16.29 MN	**20**	16.96 KL	16.63
21	16.76 BC	**21**	16.58 BC	16.67	**21**	16.93 I-L	**21**	17.42 JK	17.18
22	14.93 I-M	**22**	15.09 F-J	15.01	**22**	16.90 I-L	**22**	17.02 K-L	16.96
23	15.57 F-I	**23**	15.61 D-G	15.59	**23**	16.02 N	**23**	16.02 NO	16.02
24	15.51 G-I	**24**	15.39 E-I	15.45	**24**	17.18 I-K	**24**	16.98 K-L	17.08
25	13.62 P	**25**	13.71 N	13.67	**25**	15.43 O	**25**	15.70 O	15.57
26	14.51 M-O	**26**	14.54 J-M	14.53	**26**	16.19 N	**26**	16.36 MN	16.28
27	14.54 L-O	**27**	14.46 J-M	14.50	**27**	17.24 I-K	**27**	17.05 KL	17.15
28	12.72 R	**28**	12.89 O	12.81	**28**	**20.03 A**	**28**	**20.31 B**	20.17
29	15.21 I_L	**29**	15.75 D-F	15.48	**29**	18.51 D	**29**	18.45 E-G	18.48
30	15.89 E-H	**30**	15.93 C-E	15.91	**30**	18.64 D	**30**	18.68 D-F	18.66
31	15.35 H-K	**31**	14.80 H-M	15.08	**31**	18.40 DE	**31**	17.13 KL	17.77
35	**16.92 B**	**35**	15.38 E-I	16.15	**35**	18.60 D	**35**	18.46 D-G	18.53
36	16.72 B-D	**36**	16.55 B-C	16.64	**36**	16.96 I-L	**36**	17.08 KL	17.02
37	15.91 E-H	**37**	15.95 C-E	15.93	**37**	17.29 H-J	**37**	18.04 G-I	17.67
38	14.21 N-P	**38**	14.15 M-N	14.18	**38**	18.30 D-F	**38**	18.36 F-H	18.33
40	15.02 I-M	**40**	15.00 G-K	15.01	**40**	18.80 CD	**40**	18.90 C-E	18.85
42	**16.88 B**	**42**	**16.94 B**	16.91	**42**	19.29 BC	**42**	19.00 CD	19.15
43	14.46 M-O	**43**	14.34 K-N	14.40	**43**	18.50 D	**43**	18.54 D-G	18.52
LSD: 0.683					LSD: 0.538				

Linoleic Acid (C18:2) (%)

It was determined that the year × genotype interaction is important, that is, the linoleic acid performances of genotypes vary under climatic conditions in different growing seasons (Table 11). The average linoleic acid value in 2020 is 17.64%, and the highest linoleic acid values belong to genotypes 9 (20.49%) and 28 (20.03%). These genotypes were followed by genotype number 4 (19.45%). In 2021, the average linoleic acid value of all genotypes was 17.74%, and the genotype containing the highest linoleic acid value was again genotype 9. In line with the findings, it was observed that genotypes 9 and 28 were the genotypes with the highest linoleic acid content in both harvest years, regardless of ecological factors, and were visibly separated from other accessions. A similar situation is also valid for genotypes 25 and 23, which show the lowest linoleic acid value. In both crop years, they ranked last by maintaining the lowest linoleic acid content, and similarly, genotypes 16 and 26 were among the 5 genotypes with the lowest linoleic acid content in

both years. Therefore, the linoleic acid content is independent of ecological conditions. It is thought that linoleic acid content will not show significant differences according to years and may be a genotypic feature (Table 9).

Alpha-linolenic acid (ALA) (%)

Since the genotype x year interaction is insignificant, evaluations for this quality parameter were made over both years and two-year averages (Table 11). In 2020, the average a-linolenic acid value was 36.97%, and the highest a-linolenic acid value was obtained from genotype no. 2 originating from Georgia, with an average of 39.45%. In 2021, the average a-linolenic acid value of all genotypes was 37.24%, and the highest a-linolenic acid value was gained from genotype number 8, which is of Swedish origin (39.63%). Based on the two-year average, it was determined that genotypes 8, 2, and 13 were the genotypes with the highest α-linolenic acid content, regardless of ecological factors, and were visibly separated from other accessions. A similar situation is valid for genotypes 42 and 28, which show the lowest α-linolenic acid value (Table 10). Therefore, it is thought that the a-linolenic acid content is independent of the annual changes in the ecological conditions of Mediterranean regions.

Table 10. Alpha-linolenic acid and erucic acid values in 2020-2021

Alpha-Linolenic Acid (%)					**Erucic acid (%)**				
2020		**2021**		**Two years**	**2020**		**2021**		**Two years**
Genotype No	**Alpha-Linolenic Acid**	**Genotype No**	**Alpha-Linolenic Acid**	**Mean**	**Genotype No**	**Erucic acid**	**Genotype No**	**Erucic acid**	**Mean**
1	38.54	**1**	37.62	38.07 D-H	**1**	2.78 E-J	**1**	2.67 G-L	2.73
2	39.45	**2**	39.15	**39.29 AB**	**2**	2.81 D-I	**2**	2.78 F-H	2.80
4	37.66	**4**	37.66	37.65 F-J	**4**	2.76 F-J	**4**	2.71 F-K	2.74
7	38.61	**7**	38.85	38.73 A-D	**7**	2.72 F-K	**7**	2.76 F-I	2.74
8	39.42	**8**	39.63	**39.52 A**	**8**	2.91 D-F	**8**	2.88 C-F	2.90
9	35.57	**9**	34.91	35.23 RS	**9**	2.56 K-O	**9**	2.75 F-J	2.66
10	38.56	**10**	38.58	38.57 B-E	**10**	2.84 D-H	**10**	2.86 D-G	2.85
11	38.20	**11**	38.32	38.25 C-F	**11**	2.52 L-O	**11**	2.72 F-K	2.62
13	39.07	**13**	38.86	38.96 A-C	**13**	2.75 F-K	**13**	2.78 F-H	2.77
14	35.97	**14**	36.01	35.98 N-R	**14**	2.59 J-N	**14**	2.60 H-L	2.60
15	36.93	**15**	37.67	37.29 H-K	**15**	2.97 DE	**15**	2.54 K-M	2.76
16	36.18	**16**	36.52	36.34 M-P	**16**	2.47 N-P	**16**	2.36 M-O	2.42
17	37.65	**17**	38.80	38.22 C-F	**17**	2.61 I-N	**17**	2.60 H-L	2.61
19	36.67	**19**	37.95	37.30 H-K	**19**	2.46 N-P	**19**	2.66 G-L	2.56
20	36.73	**20**	38.11	37.41 G-J	**20**	2.70 G-L	**20**	2.66 G-L	2.68
21	35.18	**21**	36.37	35.77 O-R	**21**	2.88 D-G	**21**	2.67 G-L	2.78
22	35.90	**22**	36.41	36.15 M-P	**22**	**3.33 B**	**22**	3.05 CD	3.19
23	37.91	**23**	37.67	37.78 E-I	**23**	2.65 H-N	**23**	2.78 F-H	2.72
24	36.86	**24**	37.01	36.93 J-M	**24**	2.60 J-N	**24**	2.55 J-M	2.58
25	37.95	**25**	38.48	38.21 C-G	**25**	**3.68 A**	**25**	**3.49 A**	3.59
26	36.71	**26**	37.13	36.91 J-M	**26**	**3.39 B**	**26**	**3.28 B**	3.34
27	38.83	**27**	38.35	38.58 B-E	**27**	2.74 F-K	**27**	2.60 H-L	2.67
28	34.86	**28**	34.73	34.79 S	**28**	3.19 BC	**28**	2.99 C-E	3.09
29	38.34	**29**	37.66	38.00 D-H	**29**	2.23 RS	**29**	1.88 P	2.06
30	36.00	**30**	36.35	36.17 M-P	**30**	2.50 M-P	**30**	2.31 NO	2.41
31	35.91	**31**	38.46	37.18 I-L	**31**	2.61 I-N	**31**	2.78 F-H	2.70
35	35.34	**35**	36.03	35.68 P-R	**35**	2.30 P-S	**35**	2.52 K-M	2.41
36	36.12	**36**	36.32	36.21 M-P	**36**	2.39 O-R	**36**	2.48 L-N	2.44
37	36.59	**37**	36.60	36.59 K-N	**37**	2.69 G-M	**37**	2.61 H-L	2.65
38	36.56	**38**	36.49	36.52 K-O	**38**	3.01 CD	**38**	3.06 C	3.04
40	35.80	**40**	35.60	35.69 PR	**40**	2.76 F-J	**40**	2.82 E-G	2.79
42	33.73	**42**	34.04	33.88 T	**42**	2.16 S	**42**	2.24 O	2.20
43	36.25	**43**	36.69	36.46 L-P	**43**	2.83 D-H	**43**	2.79 E-H	2.81
LSD: 0.803					LSD: 0.204				

Erucic Acid (C22:1) (%)

Year × genotype interaction was important for Erucic acid, that is, the erucic acid performances of genotypes varied under climatic conditions in different growing seasons (Table 11). The average erucic acid value in the first year was 2.73%, and the highest erucic acid value was genotype 25 originating from Denmark with a rate of 3.68%. Genotype 25 was followed by genotypes 26 and 22 of Swedish origin in group B. In 2021, the average erucic acid value of all genotypes was 2.70%, and genotype 25 of Danish origin (3.49%) was observed as the genotype containing the highest erucic acid value. In line with the findings, it was revealed that genotypes 25 and 26 were the genotypes with the highest erucic acid content,

regardless of ecological or other environmental factors, and were visibly separated from other accessions. A similar situation is also valid for genotypes 42 and 29, which show the lowest erucic acid value. Therefore, it is thought that erucic acid content is independent of environmental and climate conditions, erucic acid content will not show significant differences between years and may be a genotypic property (Table 10).

Table 11. Variance analysis table for fatty acids in camelina genotypes.

		Mean Square Values					
Sources of Variation	**DF**	**Palmitic acid**	**Stearic acid**	**Oleic acid**	**Linoleic acid**	**Afa-Linolenic acid**	**Erucic acid**
Year (A)	1	0.010 ns	0.034 ns	0.002 ns	0.335 ns	2.441 ns	0.041 ns
Error 1	4	0.001	0.002	0.084	0.105	0.883	0.025
Genotype (B)	32	0.244 **	0.090 **	4.440 **	5.377 **	7.255 **	0.356 **
Year × Genotype (A × B)	32	0.036 **	0.011 **	0.252 **	0.159 **	0.469 ns	0.025**
Error	128	0.007	0.004	0.117	0.073	0.323	0.010

* and ** indicate significance at 0.05 and 0.01 levels of probability, respectively. ns; not significant.

DISCUSSION

Grain yield results from the first year of the study are consistent with those of Katar (2013) and Solis et al. (2013) who are relatively parallel to the results reported. Camellina yield is higher in different countries: Austria (1.91 t ha^{-1}), Canada (1.05 t ha^{-1}), Chile (1.41 t ha^{-1}), Denmark (1.82 t ha^{-1}), Germany (1.88 t ha^{-1}) and in Italy (2.25 t ha^{-1}). Yield-related traits in camelina genotypes were significantly affected by environmental conditions, allowing the identification of potentially good candidates for increasing seed yield. Zahuski et al. (2020) indicated that seed yield was significantly affected by climate and environmental conditions, and thousand-seed weight was also affected in the study conducted during the spring vegetation period in Poland. Besides, Angelini et al. (2020) reported that they investigated the feasibility of camelina cultivation under natural rainfall conditions in their study conducted under Mediterranean ecological conditions (Central Italy), they compared 7 different camelina varieties in spring and autumn planting times. As a result of this study, they reported that higher grain yield was obtained from autumn plantings and according to two-year data, the grain yield value of 3400 kg ha^{-1} was reached in the second year from the genotype named V3, the two-year average of this genotype was 2650 kg ha^{-1} and the general average was 1900 kg ha^{-1}. Arslan et al. (2014) who obtained similar results to our study, reported that the grain yield varied between 875-1811 kd ha^{-1} in the first year and 1066 - 4198 kg ha^{-1} in the second year as a result of a two-year study in Ankara ecological conditions. On the other hand, Kose et al. (2017) reported 8.20 kg ha^{-1} and Gesch (2014) 7.43 kg ha^{-1} grain yields. Comparing our results, the grain yield values reported by these two researchers are quite low. It is estimated that the main reason for these differences is due to variations in genotypes and ecological conditions of the location where the research was conducted.

The results obtained from plant height are similar to those of Kose et al. (2017) and Narmamatov (2021). The highest plant height (103.5 cm) in camelina genotypes was achieved from autumn sowings. Plant height plays an important role in determining the harvest index, and an increase in plant height generally reveals a decrease in the harvest index value (Angelini et al., 2020). Similarly, it was observed that camelina genotypes gave higher plant height in autumn sowings (Tuncturk et al., 2019).

The first lateral branch heights obtained from the research were found to be higher compared to the results of (Yalinkilic et al., 2022) who reported 16.85-36.40 cm. There are significant differences between genotypes in terms of first lateral branch height. The main reason for this difference is due to climatic conditions and comes from genotypic differences. Although the height of the first lateral branch does not have a direct effect on grain yield, it is important in terms of suitability for machine harvesting.

The numbers of capsules obtained from the research are based on Karayel et al. (2021) and Agegnehu and Honermeier (1997) are relatively similar to the results. However, Kose et al. (2017) (14.8 capsule/plant), Gore (2021) (27.5-70.5 capsule/plant) and Yılmaz et al. (2019) (62.9 capsules/plant) are different from the results reported. It is thought that differences between growing conditions, ecological conditions and genotypes are effective in the differences in observed results.

Each capsule of the camelina plant contains an average of 8-16 seeds (Kurt and Seyis, 2008). The results obtained from the research (11.44) are largely similar to the average results reported by Yildirim and Onder (2016) (13.83-16.67), although no additional phosphorus fertilization was applied. The main reason for the differences in the number of seeds in the capsule of the genotypes used in the research is genotypic differences and environmental factors between harvest years.

Two-year average thousand kernel weight data (0.99 g) was obtained from Yildirim and Onder (2016) (0.82-1.06 g), Tuncturk et al. (2019) (0.94 g) and Marquard and Kuhlmann (1986). The weight of a thousand grains in camelina generally varies between 0.8-1.6 g (Kurt and

Seyis, 2008). The difference between the results reported by the aforementioned researchers and the results obtained in this study may be due to the locations and climatic conditions, but also to the fact that different genotypes were tested.

Similar palmitic acid values were reported by Kiralan et al. (2018) and Zubr and Matthaus, (2002). However, the findings obtained by Šípalová et al (2011) differ greatly from the average values of 6.9-11.0% reported in their research. This difference may be due to the different genotypes used, the fact that the compared research was conducted as a pot experiment, and the fertilization program applied.

The average stearic acid values obtained from the research (2.43-2.46%) are similar to the results obtained by Kurt and Gore (2018) (2.43-2.77%) and Campbell et al. (2013) (2.6%). Kıralan et al. (2018) are partially similar to the results obtained (2.70%).

It is known that, in oilseed crops, heat during seed development greatly affects the conversion of carbohydrates to lipids and may explain herein the differences noticed in oil content (Angelini et al., 2020). Similar to this study, the two-year average oleic acid values obtained as a result of the research (15.4%) are compared to Kıralan et al. (2018), Campbell et al. (2013) and Kurt and Gore (2018) were found to be close to the results obtained.

Average linoleic acid values (17.64-17.74%). Kurt and Gore (2018), (16.0-20.3%), Campbell et al. (2013) (18.2%) and are largely similar to the results obtained by Kıralan et al. (2018) (17.66%).

In a study conducted in Central Anatolia, where the winter season is quite cold and snowy, it was reported that linolenic acid contents were obtained much lower than in our study (Katar and Katar, 2017). Average a-linolenic acid values were similar to some studies conducted (Marquard and Khulmann, 1986; Zubr and Matthaus, 2002). However, these results are consistent with those of Campbell et al. (2013) (28%), it was derived that the minimum a-linolenic acid value obtained in both years was higher.

Erucic acid (%) results are similar to earlier studies (Kuzmanović et al., 2021; Marquard and Khulmann, 1986; Basoglu, 1986). However, Campbell et al. (2013) are quite different from the average erucic acid value of 4%. Although the amounts of erucic acid contained in the genotypes used in the research vary slightly from year to year, there is no significant change in their rankings depending on the amount of erucic acid contained in the genotypes in both years.

CONCLUSION

The yield performances of camelina genotypes, which are not well known in the Eastern Mediterranean, were evaluated under Mediterranean climate conditions, it was observed that the yield value of genotype number 28 (3120 kg ha^{-1}) gave promising results. This was followed by genotypes 9 (2735 kg ha^{-1}) and 1 (2651 kg ha^{-1}) in both years. It was determined that these genotypes had a genetic structure that was more tolerant to drought in terms of grain yield in the Mediterranean climate coastline. On the other hand, genotypes 2, 7, 10, 27, 35, 40 and 43 are not at the desired level in Bornova/Izmir conditions. Erucic acid, a monounsaturated fatty acid, is known to be harmful to human health. All genotypes used in this study were within the limits suitable for human consumption in terms of erucic acid content in edible oil (Vetter et al., 2020) and all genotypes used in the study were of quality that can be used as cooking oil. It has been understood that Camelina cultivation can be done with natural rainfall conditions in regions where the Mediterranean climate prevails, where drought stress has begun to be seen, and it is also concluded that promising genotypes with high oil quality can be evaluated in plant breeding to combine yield and quality.

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