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Investigation of Yield and Yield Components of Some Flax (*Linum usitatissimum* L.) Varieties in Ankara Ecological Conditions

Bazı Keten (*Linum usitatissimum* L.) Çeşitlerinin Verim ve Verim Unsurlarının Ankara Ekolojik Koşullarında Araştırılması

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Abstract: This study was carried out to determine the effects of some flax varieties on yield and yield components in Ankara ecological conditions in 2021. The study was established with 10 flax varieties 3 replications according to the Randomized Complete Block Design. In the study, plant height (cm), first branch height (cm), number of branches per plant (pieces), number of seeds in the capsule (seed capsule^{-1}), 1000 seed weight (g), number of encapsulated branches per plant (pieces), oil yield (kg ha^{-1}), protein ratio (kg ha^{-1}) and seed yield (kg ha^{-1}) traits were examined. As a result of the research; There were statistically significant differences at the level of 1% between varieties in terms of yield and yield components. In the study, the highest seed yield, oil yield and protein yield (1806 – 599.7 – 428.5 kg ha^{-1}) were obtained from Clli-1412 variety.

Keywords: Flax, variety, seed yield, oil yield, protein yield

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Öz: Bu çalışma, 2021 yılında Ankara ekolojik koşullarında bazı keten çeşitlerinin verim ve verim unsurları üzerine etkilerinin belirlenmesi amacıyla yürütülmüştür. Çalışma, 10 adet keten çeşit ile tesadüf blokları deneme desenine göre 3 tekerrürlü olarak kurulmuştur. Çalışmada, bitki boyu (cm), ilk dal yüksekliği (cm), yan dal sayısı (adet), kapsüldeki tohum sayısı (tohum kapsül^{-1}), 1000 tohum ağırlığı (g), bitki başına kapsüllü dal sayısı (adet), yağ verimi (kg ha^{-1}), protein verimi (kg ha^{-1}) ve tohum verimi (kg ha^{-1}) özellikleri incelenmiştir. Araştırma sonucunda; çeşitler arasında, verim ve verim unsurları bakımından istatistikî olarak %1 düzeyinde önemli farklılıklar bulunmuştur. Çalışmada, en yüksek tohum verimi, yağ verimi ve protein verimi (1806 – 599.7 – 428.5 kg ha^{-1}) Clli-1412 çeşidinden elde edilmiştir.

Anahtar Kelimeler: Keten, çeşit, tohum verimi, yağ verimi, protein verimi

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INTRODUCTION

Flax (*Linum usitatissimum* L.) is an annual, herbaceous and highly (95%) self-pollinating species belonging to the Linaceae family (Yıldırım and Arslan, 2013; Öksüz et al., 2015; habi et al., 2019; Keskin and et al., 2020; Landoni et al., 2020; Talebi and Matsyura, 2021; Yaşar, 2023). Its spread in the world is between the Middle East, the North and Southwest of America and the Mediterranean basin, but its origin is reported to be Ethiopia, Central Asia and India (Habibollahi et al., 2016; Choudhary et al., 2017; Singh et al., 2017). Goudenhooft et al., 2018; Landoni et al., 2020; Nag et al., 2020; Xie et al., 2020; Talebi and Matsyura, 2021).

The oldest evidence of human use of flax in weaving is reported to be spun, dyed and knotted wild flax fibers from 30,000 years ago found in Dzudzuana Cave in Georgia (Anonymous, 2010; Balter, 2009; Kvavadze, 2009). However, it is thought that the cultivation of flax took place in Mesopotamia much later (Fu, 2011). In this regard, it is reported that coarse-grained flaxseed found in the Tell Ramad region in Syria and approximately 9000 years old linen fabric fragments in Çatalhöyük in Turkey (Fu, 2011; Anonymous, 2013). It is reported that it then spread to different parts of the world and reached as far as Switzerland, Germany, China and India 5000 years ago (Barber, 1991; Cullis, 2007). It is known that there were floral flax paintings on the temple walls of Ancient Egypt and that mummies were mummified using flax (Sekhri, 2011). It is also reported that Egyptian priests at that time wore only linen, as it was considered a symbol of purity (Wisseman and Williams, 1994). It is reported that Egyptian flax was first traded by the Phoenicians in the Mediterranean and the Romans used fabrics and ropes obtained from linen on their ships (Buchanan, 2012). After the decline of the Roman Empire, the demand for linen decreased, which led to a decrease in its production. However, M.S. In the 8th century, the fabric and oil obtained from linen began to be in demand again and its production became popular again (Wisseman and Williams, 1994). With the discovery of America, flaxen was brought here as well and became popular (Cullis, 2007). However, at the beginning of the 20th century, with the popularity of the cotton plant and due to the increasing costs, the production shifted mainly to Russia (Anonymous, 2003). Today, France takes the lead in fiber linen production with 141.350 ha, followed by Russia with 45.390 ha. Turkey's flax cultivation area is very small and is 8 ha. According to the FAO data for 2020, the total cultivation area of fiber flax was 285.418 ha, while the average fiber yield was 3419 kg ha^{-1} and the production was 976.113 tons.

Flax (*Linum usitatissimum* L.) is a multi-purpose plant due to its many benefits in both human and animal nutrition (Yaşar and Yetişsin, 2023). At the same time, the seeds are consumed by grinding directly, as well as oil is obtained from the seeds. The seed or oil flax cultivation area was 3.5 million ha, the average seed yield was 951.2 kg ha^{-1} and production was 3.4 million tons. Kazakhstan takes the lead in flaxseed production with 1.1 million tons, followed by Russia with 788 thousand tons, Canada ranks third with 578 thousand tons (FAO, 2020). It is seen that flax production is mostly done for seed production today. The fact that flaxseed is used as a food supplement for weight loss, its oil is used in the wood and furniture industry because it is in the class of drying oils, and it is included in bird feed mixtures increases the demand for flaxseed.

Today, the reason why it is consumed directly is due to its high nutritional properties and because it is a good diet product. It is reported that there are approximately 534 kilocalories of energy, 41 g of fat, 28 g of fiber and 20 g of protein in 100 grams of ground flaxseed (Flax Council of Canada, 2022). The omega-3 (especially alpha-linolenic acid) ratio in its oil is high. Omega-3 fatty acid is one of the essential fatty acids and is a fatty acid with high health effects (Sargi et al., 2013). The shelf life of flax oil is very short due to the excess of unsaturated acids it contains. It should be consumed fresh as it oxidizes very quickly. In the same way, if the seed is to be consumed by ground, it should be ground fresh and consumed without waiting too long. Otherwise, the oil will undergo oxidation in a short time. It is also grown as an ornamental plant due to its beautiful blue flowers.

Fiber flax performs particularly well in the temperate climate zone with abundant rainfall, while oil flax performs better in regions with relatively warmer temperatures and sufficient rainfall. For fiber production, especially in the Black Sea belt, if it is to be grown for oil or seed, it would be more appropriate

to grow it in the inner regions. The flax cultivation area of our country, which has a high potential for both flax types, is quite low.

The main purpose of this study is to see the effect of genotype and environment in terms of seed yield obtained from Ankara ecological conditions in flax varieties, to determine stable varieties, and to both make a variety suggestion and contribute to breeding studies.

MATERIAL AND METHOD

In the study, 10 varieties of flax were used as material. Some information about the varieties is given in Table 1 (Yaşar, 2023; Yaşar and Yetişsin, 2023), information about the location is given in Table 2 and climate data is given in Table 3.

Table 1. Some information about the varieties.
Çizelge 1. Çeşitler hakkında bazı bilgiler.

Genotype name	1000 Seeds Weight (g)	Flower Color	Seed Color	Oil Rate (%)	Orjin	Growing Season
Sarı 85*	5.40	white	yellow	37.7	Türkiye	Spring
Larnaka*	5.40	blue	darkbrown	37.3	Pakistan	Winter
Milas*	6.20	blue	lightbrown	36.2	Türkiye	Winter
Newtürk*	5.40	blue	darkbrown	37.1	U.S.A	Spring
Dillman*	5.20	Lightblue	brown	32.3	U.S.A	Winter
Clli-1351*	6.18	blue	lightbrown	34.8	Türkiye	Winter
Clli-1400*	6.18	blue	brown	38.2	Türkiye	Spring
Clli-1412*	6.15	lightblue	brown	35.3	Türkiye	Spring
Clli-1370*	5.69	blue	brown	35.0	Türkiye	Spring
Clli-1423*	5.76	blue	brown	34.6	Türkiye	Spring

**The seeds used in the experiment were supplied by the United States Department of Agriculture (USDA). Yaşar, 2023 and Yaşar ve Yetişsin, 2023.*

Table 2. Location information
Çizelge 2. Lokasyon koordinatları.

Location	Altitude (m)	Latitude	Longitude
TARM/ANKARA	840	39°57'19.58"K	32°48'51.31"D

Table 3. Climate data of the location.
Çizelge 3. Lokasyon iklim verileri.

Months	Average Temperature (°C) 2020-2021	Average Temperature (°C)	Average Precipitation (mm) 2020-2021	Average Precipitation (mm)
October	16.8	11.5	22.2	22.7
November	5.4	5.7	3.8	29.1
December	4.7	0.9	19.2	37.7
January	2.0	-0.9	59.9	36.3
February	2.8	1.0	13.1	34
March	2.6	5.1	72.2	35.7
April	9.3	9.7	35.4	40.2
May	16.5	14.4	19.2	46.9
June	15.9	18.1	51.6	35.7
Total			296.6	318.3

Source: *General Directorate of Meteorology-Ankara.*

When the climate data from the experimental area is examined, there is not much difference between the average temperature in the year of the experiment and the average temperature over many years. However.

while the annual total precipitation for the long-term average was 318.3 mm the total precipitation amount in the trial year was 296.6 mm.

Table 4. Trial area soil properties.
Çizelge 4. Deneme alanı toprak özellikleri.

Depth (cm)	Soil Constituency Class	pH	Salinity (dS m^{-1})	Lime (%)	Organic Matter (%)	Available Phosphorus P_2O_5 (kg ha^{-1})
0-40	CL	7.38	1.18	28	1.63	97

When the results in Table 4 are examined; the soil is clayey-loamy. poor in organic matter 1.63%. the amount of available phosphorus is 9.7% it has a slightly alkaline (pH=7.7- 7.8) and calcareous soil (28%) and the salt content is low (1.18 dS m^{-1}).

The study was established in the field of Ankara Field Crops Central Research Institute in 2021 with 10 varieties according to the Randomized Complete Block Design with 3 replications (Açıkgöz, 1993). In the experiment row spacing was 20 cm plot length was 4 m and 6 rows were planted on April 5. 2021 (Tunçtürk, 2007). Trial sowing was done manually on the opened incisors. In the experiment. organomineral fertilization was made at a rate of 100 kg per hectare. Weed hoeing was done when the plants were 10-12 cm. The experiment was irrigated twice, one as emerged and the other before flowering.

The harvest of the experiment was done on August 20. 2021. during the yellow ripening period. In the harvest, one row from each side and 0.5 m from the ends of the parcels were not harvested as an edge effect (Tunçtürk, 2007). In addition, 10 plants were taken from the harvest area of each parcel before harvesting, plant height, first branch height, number of branches per plant, number of seeds in the capsule, 1000 seed weight and number of encapsulated branches per plant were determined. Seed yield per hectare was determined from the product obtained from the harvest area. The oil ratio to be used in the calculation of the oil yield and the protein ratio to be used in the calculation of the protein yield were examined from the seeds of 10 plants taken from the plots.

Fixed oil ratio analyses were performed using the Soxhlet device and protein ratio analyses were performed using the Kjeldahl method. Statistical analyzes of the obtained values were made using the 'JMP' statistical program and the differences between the averages were tested with the Duncan multiple comparison method.

RESULTS AND DISCUSSION

The analysis of the variance table (Table 5) of the values of the properties examined in the experiment and the table of the mean values and the formed groups (Table 6) are given below.

Table 5. Analysis of the variance table of the values of the traits examined in the trial.
Çizelge 5. Denemede imcelenen özelliklerin varyans analiz tablosu.

Variation Sources	DF	Plant height	Number of seeds in the capsule	Number of branches per plant	Number of encapsulated branches per plant	First branch height	1000 seed weight	Seed yield	Oil yield	Protein yield
Replication	2	7.687**	0.132	0.3*	2.916*	4.908	0.022	298.3	51.538	1.817
Varieties	9	30.039*	0.677*	0.59**	3.426**	4.307	0.192	1213.42*	128.14	58.991*
Error	18	0.383	0.246	0.06	0.603	2.329	0.114	447.74	53.146	23.14
Total	29	10.09**	0.372	0.24**	1.638**	3.121	0.132	675.06	76.311	32.796
CV (%)		1.08	4.16	5.82	2.82	6.02	6.38	14.57	14.97	14.70

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

When Table 5, where variance analysis values of the experiment are given, is examined, the difference between the number of branches per plant and number of encapsulated branches per plant values of the varieties is statistically significant at the level of 1%, the plant height, number of seeds in the capsule, seed yield and protein yield values are statistically significant at the 5% level and the difference between the values obtained from first branch height, 1000 seed weight and oil yield is significant, appears to be statistically insignificant.

Table 6. Mean values of the traits examined in the experiment and the resulting groups.
Çizelge 6. Denemede incelenen özelliklerin ve elde edilen grupların ortalama değerleri.

Varieties	Plant height (cm)	Number of seeds in the capsule	Number of branches per plant	Number of encapsulated branches per plant	First branch height (cm)	1000 seed weight (g)	Seed yield (kg ha^{-1})	Oil yield (kg ha^{-1})	Protein yield (kg ha^{-1})
Newtürk	63.5 ^{a}	12.7 ^{a}	5.1 ^{a}	28.3 ^{ab}	27.93	5.73	1313 ^{c}	463.9	303.3 ^{b}
Clli-1370	61.3 ^{b}	12.3 ^{ab}	4.2 $^{b-d}$	29.1 ^{a}	25.5	5.16	1520 ^{ac}	510.4	294.9 ^{b}
Clli-1351	59.1 ^{c}	11.8 ^{bc}	4.3 ^{b}	27.1 ^{bc}	24.43	5.26	1400 ^{bc}	467.6	341.4 ^{b}
Sarı 85	56.8 ^{d}	12.3 ^{ab}	3.8 ^{d}	26.2 ^{c}	26.33	5.36	1540 ^{ac}	514.8	353.0 ^{ab}
Larnaka	55.5 ^{e}	11.8 ^{bc}	4.2 ^{bc}	27.2 ^{bc}	25.93	5.1	1216 ^{c}	391.2	288.7 ^{b}
Clli-1423	55.5 ^{e}	11.5 ^{bc}	4.0 ^{bd}	27.4 ^{bc}	24.36	4.96	1450 ^{ac}	478.7	306.3 ^{b}
Clli-1400	55.3 ^{ef}	11.0 ^{c}	3.9 ^{cd}	26.3 ^{c}	24.06	5.4	1736 ^{ab}	576.9	361.4 ^{ab}
Milas	54.9 ^{ef}	11.7 ^{bc}	4.3 ^{b}	28.9 ^{a}	24.6	5.33	1273 ^{c}	433.4	302.3 ^{b}
Clli-1412	54.7 ^{ef}	11.5 ^{bc}	4.1 ^{bd}	26.2 ^{c}	25.7	4.93	180.6 ^{a}	59.97	428.5 ^{a}
Dillman	54.2 ^{f}	12.0 ^{ab}	5.0 ^{a}	27.9 ^{ab}	24.46	5.56	126.3 ^{c}	42.96	292 ^{b}

When the values in Table 6 are examined, it is seen that there are six different groups in plant height values, the highest plant height was obtained in Newtürk variety with 63.5 cm, while the lowest plant height was obtained in Dillman variety with 54.2 cm. When studies on flax are examined, it is seen that the plant height is in the range of 30-70 cm (Gilbertson, 1993; Karaaslan and Tonçer, 2001; Akçalıcan et al., 2003; Tunçtürk, 2007; Yıldırım and Arslan, 2013; Güngör, 2020; Kushwaha et al., 2019; Aydın, 2020). In the study of Taddese and Tenaye (2018) in Ethiopia to see the effect of nitrogen on flax fiber yield, the plant height was obtained as 53.6-62.9 cm. It is seen that these obtained values give results at the same level as in the study. The values of 38.9-47.4 cm were reported by Güngör (2020) in the study carried out with the Sarı-85 variety by applying different nitrogen and phosphorus levels. were obtained. Tunçtürk and Tunçtürk (2021) reported that plant height in the Sarı-85 variety was between 36.9 and 44.1 cm when they investigated the effects of different planting times and phosphorus doses on flax yield and quality traits. It is seen that the values obtained in the studies are less than the values obtained in our study. It is reported that increasing plant height can increase the yield of the plant and the quality of the product. as it increases the number of branches and surface area in the plant and increases the production of dry matter in the plant due to the increase in the surface where photosynthesis takes place (Fischer and Maurer, 1978; Salisbury and Ross, 1985). It is reported that 50-70 cm plant height is suitable for oil flax (Karaaslan and Tonçer, 2001). It is reported that a plant height of 40-65 cm is more suitable for oilseed flax genotypes (Ali et al.. 2016; Maurya et al.. 2017).

Branching in oil flax is one of the traits that directly affect the seed yield (Endes, 2010; Kara, 2014). Although branching is a genotypic trait in flax. It can vary depending on the sowing density. In dense sowing, plants may compete with each other for growth and form less encapsulated branches. On the contrary. in sparse sowing. If sufficient environmental conditions are available, the plant can create many branches in accordance with its existing genetic potential (Endes, 2010; Örs and Öztürk, 2018; Han, 2019; Aydın, 2020). The highest branch number value of 5.1 per plant was observed in the Newtürk variety. The lowest branch number value was obtained from Sarı 85 variety with 3.8 per plant and all the values obtained were statistically in four different groups. appears to have formed. The values obtained from the study were higher than Tunçtürk's (2007) 3.4 -3.7 per plant, lower than the 6.1 -11.6 per plant value of Han (2019) and

Güngör (2020) were found to be compatible with 3.9 -5.8 per plant and 4.4 -7.2 per plant for Kushwaha et al. (2019).

Studies show that the number of encapsulated branches in the flax plant can vary between 1-43 and can vary with the effect of genetic structure and environmental factors (Bazzaz and Harper, 1976; Gubbels, 1978; Elsahookie, 1978; Yıldırım, 1998; Gabiana et al., 2005; Hall et al., 2016; Aydın, 2020). When the environmental conditions are sufficient for the variety, the yield is expected to increase in parallel with the increase in the number of encapsulated branches. When Table 6 is examined, it is seen that the number of encapsulated branches is in parallel with the yield values. In the study, three different groups were formed in the number of encapsulated branches per plant and the highest number of encapsulated branches was obtained in Clli 1370 with 29.1 while the lowest number of encapsulated branches was obtained in Clli 1400 with 26.3. The obtained values support the studies carried out.

Seed yield is one of the most considered selection criteria for field crops grown for seed. Seed yield is a trait that is affected by more than one factor. Many studies are showing that this situation is valid for the flax plant (Bazzaz and Harper, 1976; Elsahookie, 1978; Khurana and Dubey, 1988; Yıldırım, 2005; Tunçtürk, 2007; Smykal et al., 2011; Kara, 2014; Güngör, 20209; Han, 2019; Asadi et al., 2019; Kushwaha et al., 2019; Aydın, 2020). The study found three groups of seed yield, with Clli 1412 variety having the highest yield with 1806 kg ha-1, while the lowest seed yield was obtained in Larnaca variety with 1216 kg ha-1. Data from the study, Ghatak et al. (1990) 311-579 kg ha^{-1}, Uzun (1992) 591-799 kg ha^{-1}, Bassi and Badiyala (1992) 566-931 kg ha^{-1}, Diri (1996) 234 -1235 kg ha^{-1} and Geleta (1999) 459-521 kg ha^{-1}, Asadi et al. (2019) 315-945 kg ha^{-1}, Güngör (2020) 244-460 kg ha^{-1}, Han (2019) 729-1429 kg ha^{-1}, Kurt et al. (2005) 1097-2747 kg ha^{-1} values, İncekara (1979)'s 400-1500 kg ha^{-1}, Dorell (1973)'s 500-1400 kg ha^{-1}, Elsahookie (1978)'s 1261-1380 kg ha^{-1}, Gubbels (1978)'s 1000- 1410 kg ha^{-1}, Singh et al. (1985) 981-1930 kg ha^{-1}, Popa (1986) 1250-1850 kg ha^{-1}, Tabara (1987) 1360-1750 kg ha^{-1}, Khurana and Dubey (1988) 830 -1064 kg ha^{-1}, Gubbels and Kenaschuk (1989) 1100-1240 kg ha^{-1}, Awasthi et al. (1989) 868-1246 kg ha^{-1}, Khander and Sharma (1990) 800-1950 kg ha^{-1}, Yadav et al. (1990) 810-1270 kg ha^{-1}. Dubey and Singh (1994) 1040-1590 kg ha^{-1}. Qiang and Mi (1996) 729-1425 kg ha^{-1}, Yıldırım (1998) 400-1630 kg ha^{-1}, Kushwaha et al. (2019) 1333-1695 kg ha^{-1} and Aydın (2020) 573-1898 kg ha^{-1} It was consistent with the values.

Seed yield and oil ratio are two factors that together determine oil yield. Any factor that affects one or both of these factors will also affect oil yield. Both seed yield and oil ratio are traits that are highly affected by environmental conditions as well as genetic structure. In fact, the plant has a genetic capacity and this capacity is fully revealed only with the effect of suitable environmental conditions. In other words, as environmental conditions change in a negative way. These two traits are affected in the same way in parallel. As a result, oil yield is negatively affected. When the values obtained from the study are examined, it is seen that the oil yield varies between 391.2 kg ha^{-1} to 599.7 kg ha^{-1}, although there was no statistical difference between the varieties, the highest value was obtained from Clli 1412 variety and the lowest value was obtained from Larnaca variety. Obtained oil yield values are higher than Tunçtürk (2007)'s 376 -399 kg ha^{-1}, Güngör (2020)'s 55 -173 kg ha^{-1} and Asadi et al.(2019)'s 108 -325 kg ha^{-1}, It was found to be compatible with Han (2019)'s value of 214 -601 kg ha^{-1}.

Protein yield directly affects seed yield and protein ratio. Increasing either or both of these will naturally increase the amount of protein yield to be obtained from the hectare. When evaluated from this point of view, if the protein ratio of the variety with the highest seed yield is at an acceptable level, it is expected that the protein yield will be high. When the protein yield values are examined, it is seen that the highest value was obtained in Clli 1412 variety with 428.5 kg ha^{-1}, the lowest value was obtained in Dillman variety with 292.0 kg ha^{-1} and the values obtained from the study statistically formed two different groups. The obtained values were found to be higher than Tunçtürk's (2007) 215 -234 kg ha^{-1} and Aydın (2020) 221 -280 kg ha^{-1} values. This can be explained by the effect of genotype × environment interaction.

1000 seed weight is an important selection criterion in cultivated plants grown for their seeds and it is a desired trait to be high (Vollman and Rajcan, 2009; Kara, 2014). Although 1000 seed weight is a genotypic trait, it may decrease with the effect of insufficient environmental conditions or the effect of densing

sowing. When the values obtained from the study are examined, it is seen that the highest 1000 seed weight was obtained from Newtürk variety with 5.73 g and the lowest 1000 seed weight was obtained from Clli 1412 varieties. although there was no statistical difference between the varieties. Data obtained from the study, Ghanbari-odivi et al. (2013) 5.0-5.3 g Yıldırım (2005) 3.5-7.2 g Diri (1996) 5.3-7.0 g and Aydın (2020) 4.8-7.1 g, It is compatible with values.

It is reported that the capsule of the flax plant is genetically composed of 2 compartments. each compartment consists of 5 carpels. and a capsule can produce 10 seeds (Durrant, 1976; İncekara, 1979). In addition, it is reported that the number of seeds in the capsule of the flax plant can vary with the effect of genetic structure and environmental conditions (Akçalıcan et al., 2003; Bozkurt and Kurt, 2007). According to the results obtained from the study, three different groups were formed in the values of the number of seeds in the capsule. and the highest number of seeds was obtained in Newtürk variety with 12.7, while the lowest number of seeds was obtained in Clli 1400 variety with 11.0. These values are 7.0-7.2 by Elsahookie (1978), 6.0-8.0 by Crowley (1988), 6.1-7.1 by Khurana and Dubey (1988), Yadav et al. (1990) 6.1-8.1 and Yıldırım (2005) 8.0-9.0.

Although the height of the first branch differs according to the fiber and oil types. In general, in terms of suitability for machine harvesting, the first branch height in oil flax is desired to be at a height where the combined harvester table can harvest the encapsulated branches. On the other hand, an increase in the number of branches in oily varieties will lead to an increase in seed yield due to an increase in the number of capsules in fiber flax. On the other hand, since the aim is not seed yield, starting branching from above is a desirable feature in terms of increasing the technical stem length (Yıldırım and Arslan, 2013; Kara, 2014). Studies on oil flax show that the height of the first branch is between 12-45 cm (Gubbels, 1978; Diepenbrock and Iwerson, 1989; Endes, 2010; Kara, 2014; Örs and Öztürk, 2018; Aydın, 2020). Although there was no statistical difference between the varieties, the highest number of branches was obtained in the Newtürk variety with 5.1 while the lowest number of branches was obtained in the Sarı 85 variety with 3.8. Although there was no statistical difference between the varieties, the highest number of branches was obtained in the Newtürk variety with 5.1 while the lowest number of branches was obtained in the Sarı 85 variety with 3.8. The first branch height is a genetic trait, but it is a trait that can be affected by environmental conditions, especially dense sowing.

CONCLUSION

When the 10 flax varieties were evaluated as a whole in terms of the investigated traits in Ankara ecological conditions, the highest seed yield (1806 kg ha^{-1}), oil yield (599.7 kg ha^{-1}) and protein yield (428.5 kg ha^{-1}) were obtained in Clli 1412 variety. This was followed by Clli 1400 cultivars with 1736 kg ha^{-1} seed yield, 361.4 kg ha^{-1} oil yield and 361.4 kg ha^{-1} protein yield. However, it was concluded that all varieties used in the study can be recommended in Ankara ecological conditions in terms of yield and yield components.

CONFLICT OF INTEREST

The author(s) declare that there is no conflict of interest under this title.

DECLARATION OF AUTHOR CONTRIBUTION

The author(s) contributed equally under this title.

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