OKÜ Fen Bilimleri Enstitüsü Dergisi
5(2): 643-652, 2022

OKU Journal of The Institute of Science and Technology, 5(2): 643-652, 2022

Osmaniye Korkut Ata Üniversitesi
Fen Bilimleri Enstitüsü
Dergisi

Osmaniye Korkut Ata University
Journal of The Institute of Science and Technology

Determination of Some Agricultural and Technological Characteristics of Camelina [*Camelina sativa* (L.) Crantz] in Kütahya Ecological Conditions

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Research Article

Article History:
Received: 01.11.2021
Accepted: 17.01.2022
Published online: 18.07.2022

Keywords:
Camelina
Camelina sativa
Agricultural characters
Technological characters

ABSTRACT

This research was carried out to determine some agricultural and technological characteristics of camelina genotypes in Kütahya ecological conditions. The field experiment was established in the summer season of 2013 in three replications according to the Random Blocks Design. In this research 9 genotypes of foreign origin (PI304269, CR 476/65, CR 1674/90, Ames 26665, Ames 26667, Ames 26673, Ames 26676, Ames 26680 and Ames 28372) and one local population were used as plant material. As a result of the research, the plant height was 69.33 to 90.63 cm, the number of capsules per plant was 168.33 to 427.67, the number of seeds in the capsule was 8.65 to 12.37, the thousand seeds weight was 0.08 to 0.13 g, the grain yield per plant was 0.86 to 2.02 g determined. In addition, it was determined that the oil content in the seed varied between 26.66% and 35.95%. As a result, it was determined that Ames-26667, Ames-26680 and Ames-26676 genotypes are more advantageous than other genotypes. However, in order to reach a definite conclusion, the research should be carried out for at least one more year.

Ketencik [*Camelina sativa* (L.) Crantz]'in Kütahya Ekolojik Koşullarındaki Bazı Tarımsal ve Teknolojik Özelliklerinin Belirlenmesi

Araştırma Makalesi

Makale Tarihçesi:
Geliş tarihi: 01.11.2021
Kabul tarihi:17.01.2022
Online Yayınlanma: 18.07.2022

Anahtar Kelimeler:
Camelina
Camelina sativa
Tarımsal karakterler
Teknolojik karakterler

ÖZ

Bu araştırma, Kütahya ekolojik koşullarında ketencik genotiplerinin bazı tarımsal ve teknolojik özelliklerini belirlemek amacıyla yapılmıştır. Tarla denemesi 2013 yaz sezonunda Tesadüf Blokları Deneme Desenine göre üç tekerrürlü olarak kurulmuştur. Bu araştırmada bitki materyali olarak 9 yabancı kökenli genotip (PI304269, CR 476/65, CR 1674/90, Ames 26665, Ames 26667, Ames 26673, Ames 26676, Ames 26680 ve Ames 28372) ve bir yerli populasyon kullanılmıştır. Araştırma sonucunda bitki boyu 69.33-90.63 cm, bitki başına düşen kapsül sayısı 168.33-427.67, kapsül içindeki tohum sayısı 8.65-12.37, bin tane ağırlığı 0.08-0.13 g, bitki başına tane verimi 0.86-2.02 g olarak değiştiği belirlenmiştir. Ayrıca tohumdaki yağ içeriğinin %26.66-35.95 arasında değiştiği tespit edilmiştir. Sonuç olarak Ames-26667, Ames-26680 ve Ames-26676 genotiplerinin diğer genotiplere göre daha avantajlı olduğu belirlenmiştir. Ancak kesin bir sonuca varmak için araştırmanın en az bir yıl daha devam etmesi gerekmektedir.

To Cite: Kurt O., Göre M., Bilir E. Determination of Some Agricultural and Technological Characteristics of Camelina [*Camelina sativa* (L.) Crantz] in Kütahya Ecological Conditions. Osmaniye Korkut Ata Üniversitesi Fen Bilimleri Enstitüsü Dergisi 2022; 5(2): 643-652.

1. Introduction

Vegetable oils which have an important place in the nutrition of humanity, are also used in the energy sector. Due to the decrease in fossil fuels which have a large share in the energy sector, and their negative effects on the environment, interest in biofuels has gradually increased in recent years. The importance of oilseed plants that form the raw material of biodiesel which is one of the biofuels is increasing day by day due to these reasons (Öğüt et al., 2014). The vegetable source for the production of biodiesel is generally utilized from oilseed plants such as rapeseed, sunflower, soybean and palm (Göre and Kurt, 2017). However, the need for vegetable oil sources with low sensitivity to burning has also increased due to with the increase in biodiesel consumption. Camellia is one of the plants that can be used for this purpose.

Camelina is the only economically important species among the 7 widely known Camelina species included in the Brassicaceae family (Davis, 1965; Göre, 2015). Camelina which has many advantages in addition to being grown in marginal areas, is shown as an excellent source for biodiesel production due to its advantage in providing cheap raw materials (Putnam et al., 1993). The importance of camelina has increased in recent years due to the fact that the idea of supplying Omega-3 sources from vegetable sources together with the difficulties in meeting the nutritional and energy needs of the increasing world population. Camelina seeds have 35-45% oil and 18-20% protein content (Toncea et al., 2013). Camelina oil is also considered as an edible oil due to its low saturated fatty acid content and high content of polyunsaturated fatty acids and is classified as a drying oil due to its iodine number (144) (Robinson, 1987).

Agricultural research on camelina plant has been carried out by various researchers in both Europe and North America and it has been determined that it is an ideal plant for a sustainable agriculture system (Gugel and Falk, 2006; Zannetti et al., 2017). Compared to other oil crops, camelina has the ability to give higher yields in much more inadequate soil and climatic conditions (Kumari et al., 2012). In addition, the intensity of agronomic and breeding studies on camelina has increased due to reasons such as the short vegetation period, the fact that it can be grown in winter and summer and has certain phytochemical substances with natural resistance that the plant has produced against many diseases and pests (Urbaniak et al., 2008).

Since oilseed production is not sufficient in Turkey, oilseeds are imported from abroad and used in crude oil production in addition to domestic production. At the same time, raw oil is imported directly from abroad and used domestically (Onat et al., 2017). There is a need to integrate the potential of alternative oil crops into the agricultural system in order to increase oilseed production and for the oil industry to operate at full capacity in Turkey. Therefore, this research was carried out in order to determine some agricultural and technological characteristics of the camelina plant in Kütahya ecological conditions in terms of integrating it into our agricultural system.

2. Material and Method

2.1. Plant Material and General Information about Experimental Area

In this research 9 genotypes of foreign origin and one local population were used as plant material (Table 1).

Table 1. Data on IP numbers and origins of plant materials in the experiment

Number	IP Number	Origin
1	Local	Turkey
2	PI 304269	Sweden
3	PI 633192-CR 476/65	Germany
4	PI 633194	Germany
5	PI 650142	Denmark
6	PI650144	Denmark
7	PI 650150	Denmark
8	PI 650153	Russia
9	PI 650157	Russia
10	PI650168	USA

The latitude and longitude of the research area is 39.223 ° N-29.560 ° E and its altitude from the sea is 1004 meters. The soil in the research area has a good potassium content, moderate phosphorus content, good organic matter content, slightly calcareous (11.50%) in terms of lime content and slightly salty (0.025%) in terms of total salt content. The soil pH is between 7.5-7.7, and the soil is slightly alkaline. The soil structure has a loamy structure with clay.

Table 2. Some climate data of the experiment area (2013 and last 55 years)

Months	**Temperature (°C)**		**Rainfall (mm)**		**Relative Humidity (%)**	
	Growing Seasons	Long Years	Growing Seasons	Long Years	Growing Seasons	Long Years
June	19.4	18..4	47..8	33.6	55.0	56.9
July	20.9	20.9	22.0	19.8	51.4	54.7
August	21.9	20.6	4.8	14.8	48.7	50.6
September	16.6	16.5	1.7	22.0	50.4	52.6

It is seen that the average amount of humidity in the research season is less than the average of long years. The average monthly temperature is higher than the average temperature of long years.

Although the monthly total rainfall is higher than the average of long years in June and July, it is far below the average of many years in August and September, and it is almost negligible (Table 2).

2.2. Method

Before sowing, the research area was plowed with a tractor and the seed bed was prepared by pulling a rake after plowing. The research was established on 05.06.2013 in the Randomized Blocks Experiment design with 3 repetitions. There are 5 rows of 4 m in length with 20 cm between rows and 2-3 cm above rows in the parcels. 1,0-meter space has been given between parcels and between blocks. Irrigation was done 3 times in the field capacity due to the high average temperature value and low rainfall values during the research period. It was struggled with weeds manually and mechanically as a maintenance process. 8 kg da^{-1} nitrogen, 4 kg da^{-1} potassium and 3 kg da^{-1} sulfur were applied in pure form. No chemical pesticides were used before and after sowing. The harvest was done manually between 10.09.2013 and 25.09.2013 when genotypes reached physiological maturity.

2.3. Statistical Analysis

Data on plant height, number of capsules per plant, seed number in capsule, seed yield and thousand seed weight were taken from 10 plant samples. Crude oil analysis for determination of technological properties was performed according to Soxhelet Extraction method.

SPSS Statistical Data Package Program was used in the statistical analysis of the data obtained from the research. Duncan multiple comparison test was used for grouping means.

3. Results and Discussion

It was determined that the difference between camelina genotypes in terms of plant height was significant ($p<0.01$). Plant height in the evaluated camelina genotypes ranged from 69.33 cm to 90.63 cm, with an average plant height of 81.46 cm (Figure 1a). As a result of the multiple comparison test, it was determined that the tallest plant height was in the CR-1674/90 genotype (Table 3). Plant height in camelina plant was reported as 72.00 cm by Vollmann et al. (1996), 75.14 cm by Karahoca and Kırıcı (2005), 72.10 cm by Koncius and Karcauskiene (2010), 72,00-82,00 cm by Kumari et al. (2012) and 69.00-97.38 cm by Çoban and Önder (2014). The results found in this study are similar to the results of the researchers above. However, the data obtained on the plant height in this research are longer than the values given as 53.50 cm (Kara, 1994) and 47.25-51.50 cm (Sadhuram et al., 2010) in camelina plant and it is shorter than the value reported as 106.68 cm (Mason, 2011).

Table 3. Variance analysis table for some agronomic and technological characters of camelina genotypes

Genotypes	Plant Height (cm)	Number of Capsule	Seed of Number in Capsule	Thousand Seed Weight (g)	Seed yield (g^{-1} plant)	Oil Content (%)
Local	88.87^{a}	169.67	8.65^{a}	1.2^{ab}	0.86^{d}	32.76^{a}
PI - 304269	82.57^{ab}	360.33	10.81^{b}	1.2^{ab}	1.77^{abc}	35.01^{a}
CR - 476/65	82.20^{ab}	178.67	12.37^{a}	1.2^{ab}	1.04^{cd}	34.01^{a}
CR - 1674/90	90.63^{a}	168.33	11.13^{a}	0.9^{cd}	1.35^{a-d}	34.78^{a}
Ames - 26665	80.07^{ab}	215.00	9.43^{a}	1.0^{bc}	1.13^{bcd}	35.32^{a}
Ames - 26667	87.53^{a}	427.67	10.41^{a}	1.2^{ab}	2.02^{a}	34.99^{a}
Ames - 26673	84.17^{ab}	209.00	12.32^{a}	0.8^{d}	1.07^{bcd}	35.02^{a}
Ames - 26676	74.70^{bc}	342.00	10.49^{a}	1.3^{a}	1.71^{abc}	35.95^{a}
Ames - 26680	74.53^{bc}	289.33	9.48^{a}	1.1^{abc}	1.91^{ab}	33.64^{a}
Ames - 28372	69.33^{c}	286.67	9.74^{a}	1.3^{a}	1.46^{a-d}	26.66^{b}
Means	81.46	264.67	10.48	1.10	1.43	33.81
F Value	4.65	1.94	2.22	3.85	2.91	4.22
CV (%)	6.80	1.23	13.56	12.20	12.11	6.67

It was determined that the difference between camelina genotypes in terms of the number of capsules per plant was not significant. The number of capsules per plant in the evaluated camelina genotypes ranged from 168.33 to 427.67 and the average number of capsules per plant was 264.67 (Fig. 1b). Although the highest number of capsules per plant was obtained from Ames-26667 genotype with 427.67, the minimum number of capsules per plant was obtained from CR-1674/90 genotype with 168.33 (Table 3). The number of capsules per plant reported as 185 (Agegnehu and Honermeier, 1997) and 254.63 (İnan and Kırpık, 2016) in previous research and they are similar to the results of this research. However, according to the data reported that 49.66-119.00 (Çoban and Önder, 2014) and 40.15-94.75 Koç (2014) obtained the number of capsules per plant, more capsules per plant were obtained in this research.

It was determined that the difference between camelina genotypes in terms of the number of seeds in the capsule was not significant. The number of seeds per capsule in the evaluated camelina genotypes ranged from 8.65 to 12.37 and the average number of seeds per capsule was 10.48 (Fig. 1c). Although the highest number of seeds in the capsule was obtained from the CR-476/65 genotype with 12.37, the minimum number of capsules in the plant was obtained from the Local genotype with 8.65 (Table 3). The data obtained as a result of this research regarding the number of grains per capsule confirms the previous results which 7.87-11.00 (Karahoca and Kırıcı, 2005), 10.0-13.3 (Çoban and Önder, 2014), 10.28-13.43 (Koç, 2014) and 7.46-9.78 (Göre and Kurt, 2017).

It was determined that the difference between camelina genotypes in terms of thousand seed weight was significant ($p<0.01$). In the evaluated camelina genotypes, the thousand seeds weight varied between 0.8 g and 1.3 g, and the average thousand seeds weight was 1.1 g (Fig. 1d). As a result of the multiple comparison test, it was determined that two genotypes (Ames-26676 and Ames-28372) gave the best result (Table 3). Thousand seed weight in camelina plant reported as 1.34 g (Vollman et al., 1996), 1.00 g (Akk and Ilumae, 2005), 1.32 g (Karahoca and Kırıcı, 2005), 0.90-1.60 g (Gugel and Falk, 2006), 0.88- 1.24 g (Koncius and Kacauskiene, 2010), 0.86-1.36 grams (Çoban and Önder, 2014), 1,18-1,48 g (Arslan et al, 2014), 1,33 g (İnan and Kırpık, 2016), 0.82-1.06 g (Yıldırım and Önder, 2016) and 0.98-1.36 g (Göre and Kurt, 2017). These reported results are similar to the findings obtained in this research. However, it is more than the results reported as 0.42-0.46 g (Katar and Katar, 2017), 0.79-0.89 g (Koç, 2014) and 0.67-0.87 g (Akbulut, 2014).

It was determined that the difference between the Camelina genotypes in terms of seed yield was significant ($p<0.05$). In the evaluated camelina genotypes, the grain yield per plant varied between 0.86 g and 2.02 g, and the average seed yield was 1.43 g (Figure 1e). The highest seed yield per plant was obtained from Ames-26667 genotype with 2.02 g. It was determined that the Ames-26667 genotype was in the best group as a result of the multiple comparison (Table 3). It has been reported that the ripening period should not coincide with high temperatures in order to obtain high yield in camelina and also it has been reported that the seed yield in the plant varies between 0.860-1.400 g (Sadhuram et al., 2010).

It was determined that the difference between camelina genotypes in terms of oil content was significant ($p<0.01$). The oil content in the evaluated camelina genotypes varied between 26.66% and 35.95%, and the average oil content was 33.81% (Fig. 1f). It was determined that the Ames-26676 genotype was in the best group as a result of the multiple comparison test (Table 3). The oil content of camelina plant was reported as 25-30% (İncekara, 1964) and 28-37% (Atakişi, 1991) as a result of previous studies and it was confirmed by the data obtained in this research. However, the data reporting the oil content of camelina as 39-43% (Vollman et al., 1996), 37-43% (Agegnehu and Honermeier, 1997) and 42-45% (Zubr, 1997) are higher than the data obtained from this research.

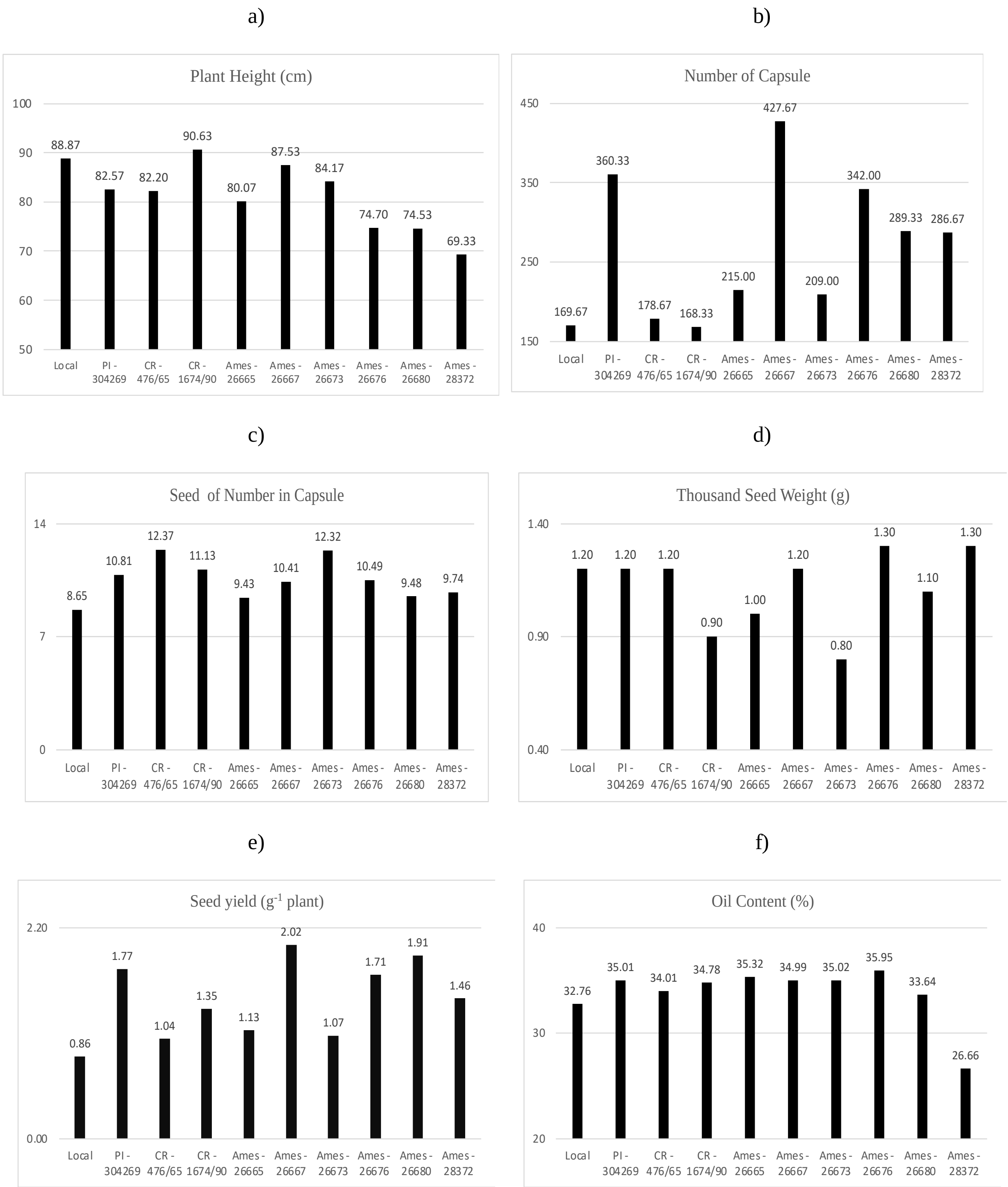

Figure 1. Change of agronomical and technological characters of camelina genotypes, a. Plant height, b. Number of capsules, c. Seed of number of capsules, d. Thousand seed weight, e. Seed yield, f. Oil content.

4. Conclusion

As a result, considering the agricultural and technological characteristics of camelina grown in Kütahya ecological conditions, it was determined that Ames-26667, Ames-26680 and Ames-26676 genotypes are more advantageous than other genotypes. However, in order to reach a definite conclusion, the research should be carried out for at least one more year. In addition, it has been decided that these three camelina genotypes can be used primarily in researches to determine the growing technique to be carried out in Kütahya ecological conditions.

Statement of Conflict of Interest

The authors of the manuscript declare that there is no conflict of interest between them.

Author's Contributions

O.K designed the research. E.B carried out field experiments. M.G analysed the data. O.K and M.G wrote the manuscript.

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