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Determination of Yield and Quality Properties of Different Crust Colored Sesame (*Sesamum indicum* L.) Varieties and Populations in Diyarbakır Conditions

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Abstract
This investigation was carried out to determination of yield and quality properties of different crust colored sesame (*Sesamum indicum* L.) varieties and populations in the experiment fields of Dicle University, Agricultural Faculty, Field Crops Department in 2016 growing season in order to determine the yield and quality components of 18 sesame varieties and populations collected from different regions of Turkey. In field experiment implemented through Randomized Block Experimental Design with three replication. The obtained data were subjected to analysis of variance by using the JMP Statistical Package Program. In the experiment; plant height, branc number per plant, capsule number per plant, capsule lenghth, capsule weight, seed number per capsule, seed yield, harvest index, oil content, protein content and fatty acid composition were observed. According to the obtained data; while the highest seed yield observed in the Mardin-Kızıltepe population (134.37 kg/da), 1000-seed weight (3.35 g) in Diyarbakır-Yerli-2, harvest index (%26.75) in Mardin-Kızıltepe, oil content (%52.90) in Ege-Manisa and protein content (%25.66) in Adana-Yerli. It was determined that the varieties and populations in dark group; have higher seed yield and higher oil content. There was no effect of the crust color on protein ratio. As a result of this study; Şırnak-Kumçatı-Dergul, Mardin-Kızıltepe, Arslanbey, Diyarbakır-Çermik-1 and Diyarbakır-Çermik-2 varieties and populations were more important than the others.

Keywords: Sesame, yield, quality components, varieties, populations.

INTRODUCTION

Sesame (Sesamum indicum L.) is one of the important oil plants because of its high and quality oil in its seeds. The oil ratio in sesame seeds is between 50 to 60%. Sesame oil unlike other vegetable oils, contains about 35 to 45% oleic and linoleic acid. Sesame oil is also extremely resistant to oxidation due to secondary substances such as sesamin (0.5-1.5%) and sesamolin (0.3-0.5%). Sesamin is particularly very effective in lowering cholesterol level of blood [7].

In 2017, about 4.5 million tons of sesame seeds were produced in the 10 million ha plantation area in the world. China and India are the world's largest producers of sesame seeds, followed by Sudan and Myanmar. Most of sesame cultivation and production in our country takes place in Balıkesir, Antalya, Muğla, Uşak and Manisa provinces. Plantation and yield of sesame seeds in our country decrease every year. Sesame planting area of Turkey in 2004 was 43,000 ha and sesame production was 23,000 tons, whereas plantation area in 2013 decreased to 24,800 ha and production decreased to 14,457 tons [1]. The annual consumption of sesame seeds in Turkey is 150 000 tons, domestic production of sesame seeds can only meet 5% of consumption. The rest of sesame seeds is imported from other countries such as Nigeria, Ethiopia, India and Mozambique. Most of the sesame seeds traded in the world are light-colored seeds, but the seeds of local varieties can vary from white to beige, light brown, yellow, brown, reddish and gray [10]. Crust color of large part of the sesame population grown in Turkey is brown that is most commonly (88%) observed in the Aegean and Mediterranean populations. Yellow crust color (38%) is seen in Marmara populations and dark brown (73%) is observed in South Eastern Anatolia populations [6].

Breeding efforts related to the development of new varieties may help Turkey from preventing sesame seeds import, and studies on determining the quality characteristics of these varieties for different uses are very important.

This study was carried out to determine the performance of 18 different sesame (Sesamum indicum L.) genotypes in Diyarbakir conditions.

MATERIALS AND METHODS

This study was conducted on the experimental fields of Field Crops Department, Agricultural Faculty in Dicle University. The experimental design was randomized blocks with three replications. Eighteen sesame varieties and populations collected from several regions of Turkey in previous studies were grouped based on their crust colors and used in the experiment. Soils in the experimental field are fine textured, poor in phosphorus and organic matter, moderately calcareous, non-saline, moderately alkaline and have high cation exchange capacity. The climate characteristics of Diyarbakir province are similar to the typical continental Southeast Anatolia climate.

Table 1. Climate data of Diyarbakır province in 2016

Climate Indicators	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
Average humidity (%)	82.5	75.2	70	59.9	56.1	35.1	25.8	24.7	31.9	36.9	56.3	78.2
Maximum temperature (^{0}C)	11.6	22.2	21.6	29.8	33.2	41.6	42.8	42.8	38.3	32.7	23.1	13.3
Minimum temperature (^{0}C)	-2.9	2.5	3.1	6.7	11.2	16.7	21.8	21.6	15.3	9.9	1.4	-1.4
Average temperature (^{0}C)	0.9	7.5	9.3	15.2	19.3	26.1	31.0	31.2	23.8	18.3	8.0	2.2
Total precipitation (mm)	79.2	62.2	39.6	18	38.2	4.2	0	0.4	3.8	18.4	56.4	138.2

* Diyarbakir Directorate of Meteorology

The average annual precipitation is 490 mm, 18% of which falls in autumn, 44% in winter, 37% in spring and 1% in summer, meaning that precipitation mostly occurs in winter and spring. The annual average temperature is 15.80 ºC, and the months with the maximum drought and temperatures are July and August [2].

The length of each plot was 4 m and the interrow spacing was 0.7 m. Seeds were planted on May 20, 2016 and sprinkler irrigation was used to provide water. The varieties and populations that came to harvest maturity were harvested by hand. The harvested plants were thoroughly dried and then blended. Agronomic and quality characteristics of sesame seeds were investigated in the study. Data for the investigated characteristics of sesame plants were analyzed with the JMP 13 statistical software and the results were grouped according to the LSD multiple comparison test.

RESULTS AND DISCUSSION

The plant height, number of capsules, length of capsules, seeds per capsule, number of branches, 1000-seed weight, harvest index, seed yield, protein ratio and oil ratio were significantly different among varieties and populations, while size of capsules was not significantly differed. The highest plant height was obtained with Diyarbakır Yerli-1 (98.80) population, while the lowest plant height was obtained with Manisa (white) (48.00 cm) variety. Sesame varieties and populations with light brown seed crust color were found to be taller than the other varieties and populations, while sesame varieties with white and beige seed crust color and populations were shorter compared to the others. The results obtained were lower than those reported by [14], [13] and [5]. Similar plant heights were reported by [12], [9], [11] and [8]. However, plant heights reported by [15] were shorter compared to our findings. The characteristics such as different genetic structures of sesame varieties and populations used in the experiment, differences of geographical origins and different soil conditions of the experimental site may significantly affect the plant height of varieties and populations.

The highest average first branch height (41.53 cm) was obtained with Şırnak-Cizre-Koruk population, while the lowest value (20.33 cm) was with obtained Manisa (white) variety. The first capsule height of cultivars and populations with light brown colored seed crust was higher than other cultivars and populations, while the varieties and populations with white and beige colored seed crust had lower values. Our results were in accordance with those reported by [15], while lower first branch heights were reported by [12], [13] and [5] compared to our findings. Day length has significant effect on the first capsule height; the formation of the first capsule of sesame varieties and populations those better adapted to day length are accelerated by passing into the earlier flowering cycle and thus reduces the initial capsule height. Initial onset of flowering was delayed in varieties and populations those not well adopted to day length, delaying the formation of the first capsule, thereby increasing the initial capsule height [15]. High initial capsule height distance is a desirable feature in machine harvesting, while if it is too high, it reduces the number of capsules per plant and directly affects and reduces the seed yield. The highest average number of capsules (154.33 capsule/plant) was obtained with Diyarbakir Çermik-1 population, while the lowest value (27.33 capsule/plant) was obtained with Manisa (white) variety. The average number of capsule was 96.07. Sesame varieties and populations with dark brown and black crust color had higher number of capsules and lower values were found in populations with white and beige crust color. Differences in genetic structures have significant impacts on the number of capsules per plant. In addition to this, different environmental and climatic factors than their origins and differences in soil conditions may also affect the number of capsules per plant. The results obtained in this study were lower than those reported by [12], similar to those reported by [11], and higher than those reported by [9], [15], [13] and [8].

When evaluating the average capsule length; the Ege Manisa population had the longest capsules with an average of 31.55 mm while the Manisa (white) variety had the shortest capsules with an average of 26.12 mm. Although there were differences among the average capsule lengths, no significant differences could be determined based on seed crust color. Therefore, definite assessment and determination could not be made based on seed crust colors of cultivars and populations. The results obtained are similar to those reported by [11]. The differences in capsule length may be attributed the variation in genetic structure along with environmental conditions, climatic factors, structure and characteristics of soils in experimental site.

When evaluating the average capsule width; the highest capsule width (8.87 mm) was obtained with Urfa Yerli variety. The lowest capsule width (7.40 mm) was obtained with Manisa (white) variety. The results obtained were higher than those reported by [11]. Ecological factors are considered the main causes of the differences in the results.

Table 2. Mean values of plant height, first capsule height, capsul number, capsule lenght, capsule width and capsule seed number of sesame genotypes and populations

Genotype /Population	Features examined					
	Plant Height (cm)	First Capsule Height (cm)	Capsule Number (per/ plant)	Capsule Length (cm)	Capsule Width (cm)	Capsule Seed Number (per/plant)
Diyarbakır yerli-1	98.80 a	39.07 a	122.87 cd	28.45 a-d	8.85	66.64 a-d
Şırnak-Kumçatı-Dergul	96.60 ab	28.13 b	146.73 ab	30.76 abc	8.57	71.23 a
Diyarbakır-Kocaköy-Arkbaşı	92.53 abc	30.27 b	132.53 bc	28.74 a-d	8.66	70.49 ab
Şırnak-Cizre-Koruh	90.22 abc	41.53 a	57.75 gh	28.04 bcd	8.13	63.73 a-d
Diyarbakır-Çermik-1	90.13 abc	29.33 b	154.33 a	30.5 abc	8.61	58.86 def
Diyarbakır-Çermik-2	89.40 abc	28.13 b	138.33 abc	28.45 a-d	8.09	66.72 a-d
Urfa Yerli	88.87 abc	26.93 bc	147.00 ab	31.1 ab	8.87	64.56 a-d
Diyarbakır-Yerli-2	84.73 ad	24.73 bcd	103.87 de	27.62 cd	8.04	62.31 cd
Muganlı	84.73 ad	26.33 bcd	91.8 ef	26.48 d	8.07	52.4 fg
Sarısu	84.27 ad	29.13 b	74.33 fg	30.3 abc	8.67	61.73 cde
Adana (yerli)	82.89 ae	28.75 b	74.03 fg	28.37 a-d	8.14	59.08 bef
Lice-Kabakaya	80.13 bf	26.40 bcd	101.27 e	26.66 d	7.57	59.36 def
Mardin-Kızıltepe	78.20 cf	21.60 cde	147.53 ab	30.60 abc	8.50	67.79 abc
Ege-Manisa	68.53 dg	21.09 cde	62.17 gh	31.55 a	7.94	66.6 a-d
Kocaköy-Arkbaşı	65.33 eh	20.86 cde	74.58 fg	29.26 a-d	7.68	63.05 bcd
Orhangazi-99	62.50 fgh	21.53 cde	44.57 hı	28.32 bcd	7.77	62.87 bcd
Osmanlı-99	54.43 gh	16.77 e	28.27 ı	27.84 cd	7.90	53.81 efg
Manisa (beyaz)	48.00 h	20.33	27.33 ı	26.12 d	7.40	47.5 g
Average	80.01	26.72	96.07	28.84	8.19	62.15
L.S.D. (%5)	17.72	6.28	21.47	3.18	1.10	8.01

Şırnak-Kumçatı-Dergul population had the highest number of capsules per seed (71.23 capsule/seed), while Manisa (White) variety had the lowest number of capsules (47.5 capsule/seed). Sesame varieties and populations with dark brown and black color had higher number of capsules per seed compared to the others. The results obtained were similar to those found by [12], [5] and [13], while our results were higher than those reported by [15] and [8]. The number of capsules per seed directly affect the seed yield. Seeding time and plant density in per unit area affect the number of seeds per capsule. The number of seeds per capsule decreases when the plant density in the per unit area increases, while the number of seeds is increased in early seedings [3].

Diyarbakir Çermik-1 population had the maximum number of branches (10.2 branch/plant), while Osmanlı-99 variety had the lowest number of branches (2.83 branch/ plant). The number of branches were significantly different among varieties and populations; however, the differences were not directly related to the seed crust colors. Our results on number of branches per plant were higher than those reported by [15], [13], [5] and [8]. The number of branches increases with the increase in interrow and intra-row spacings. The number of capsules increases with the increase in the number of branches, thus branching is required for sesame plants [13].

The highest 1000-seed weight (3.35 g) was obtained with Diyarbakır Yerli-2 population, while the lowest 1000-seed weight (2.17 g) was obtained with Osmanlı-99 variety. Varieties and populations with moderate brown and dark brown crust color seeds had higher 1000-seed weight compared to those with beige and white seed crust color. The 1000-seed weight of sesame varieties and populations may differ due to their different genetic structures. High 1000-seed weight is also another indication of full and large seeds. The results for 1000-seed weights were lower than those reported by [9], [11] and [14], similar to those found by [15]. In contrast to our results, 1000-seed weights reported by [13] and [8] were higher than our findings.

Mardin-Kızıltepe population had the highest average harvest index value (26.74%), while Manisa (white) variety had the lowest average harvest index value (2.19%). The varieties and populations with dark sesame seed crust color had higher harvest index (%) values, while the varieties and populations with white and beige crust color had lower harvest index (%) values. The differences in harvest index among cultivars and populations are related to the genetic structure of plants. Growth environment, fertilizer use, climatic conditions, and cultural applications have also significant effect on harvest index. The harvest index (%) is one of the leading factors affecting the seed yield. The results obtained were lower than those reported by [9].

The Mardin-Kızıltepe population had the highest seed yield with 1343.7 kg/ha whereas the Ottoman-99 variety had the lowest seed yield with 73.3 kg/ha. The varieties and populations with dark sesame seed crust color had higher seed yield, while varieties and populations with white and beige seed crust color had lower seed yield. Generally, dark colored sesame varieties and populations had higher seed yield potency than light ones. The results obtained were lower than those found by [9] and [14] and similar to the findings of [15], [13] and [8]. In contrast to our results, [11] reported higher seed yields. The differences in seed yield reported by various researches may be attributed to the differences in genetic structure and yield potentials of varieties and populations, climate and environmental conditions, variation in cultural practices applied during growing season and differences in soil conditions.

When evaluating the protein ratio; Adana (domestic) population had the highest protein ratio (25.66%), while Orhangazi-99 variety had the lowest protein ratio (17%). Seed crust color did not have any effect on the protein ratio. The results obtained were in accordance with those reported by [9], [15] and [8]. Cultivation techniques, climate and environmental conditions are effective on sesame protein ratio. The protein ratio increases as the interrow distance increases.

The highest oil ratio (52.9%) was obtained with Ege-Manisa population, while Muganlı variety had the lowest oil rate (36.4%). Sesame varieties and populations with dark brown and black seed crust colors had a higher oil ratio compared to sesame varieties and populations with light brown and medium sesame seed crust colors.

The results of our study were in agreement with those reported by [9], [15] and [8]. In contrast to our results, [14] found lower and found higher oil ratio than our findings. The oil percentage in sesame can vary depending on the region

where it is grown. The oil ratio of sesame grown in northern and high-altitude areas is lower than sesame grown in southern and low-altitude regions [7]. Factors such as water stress and drought can also cause a low ratio of sesame oil. However, [4] found that oil content of sesame genotypes with black crust color are higher than light-colored sesame genotypes.

Table 3. Mean values of branch number, 1000 seed weight, harvest index, seed yield, protein ratio and oil ratio of sesame genotypes and populations

Genotype /Population	Features examined					
	Branch Number (per/ plant)	1000 Seed Weight (gr)	Harvest Index (%)	Seed Yield (kg/da)	Protein ratio (%)	Oil ratio (%)
Diyarbakır yerli-1	9.27 ab	3.01 abc	11.08 fg	35.63 ef	23.63 c	52.3 b
Şırnak-Kumçatı-Dergul	4.77 hı	3.02 abc	22.42 b	126.70 a	24.92 b	47.8 hı
Diyarbakır-Kocaköy-Arkbaşı	9.07 ab	2.72 bc	11.07 fg	40.36 def	23.32 cd	50.9 d
Şırnak-Cizre-Koruh	7.38 cde	2.78 bc	2.99 jk	12.05 ıj	21.07 h	42.1 m
Diyarbakır-Çermik-1	10.20 a	2.98 abc	15.30 d	51.63 c	21.79 g	46.9 j
Diyarbakır-Çermik-2	8.00 bcd	2.78 bc	15.31 d	55.66 c	23.56 c	51.6 c
Urfa Yerli	7.73 b-e	2.95 bc	20.45 bc	82.70 b	22.62 ef	52.5 b
Diyarbakır-Yerli-2	8.73 abc	3.35 a	20.13 c	52.61 c	22.85 de	47.5 ı
Muganlı	5.33 ghı	3.08 ab	12.74 ef	31.28 fg	23.40 cd	36.4 n
Sarısu	6.93 d-g	2.67 cd	9.70 ghı	22.54 gh	22.07 fg	48.6 g
Adana (yerli)	5.72 fgh	2.76 bc	10.93 fgh	47.28 cd	25.66 a	49.5 f
Lice-Kabakaya	7.07 def	2.91 bc	8.96 hı	36.74 ef	25.13 ab	46.0 l
Mardin-Kızıltepe	4.07 ıj	2.75 bc	26.74 a	134.37 a	22.85 de	50.1 e
Ege-Manisa	3.76 ıj	2.95 bc	7.99 ı	36.29 ef	23.65 c	52.9 a
Kocaköy-Arkbaşı	6.33 efg	2.76 bc	13.98 de	45.66 cde	21.14 h	48.5 g
Orhangazi-99	5.37 ghı	2.80 bc	5.02 j	17.56 hı	17.00 j	46.4 k
Osmanlı-99	2.83 j	2.17 e	2.46 k	7.33 j	17.22 ıj	48.1 h
Manisa (beyaz)	4.50 hı	2.30 de	2.19 k	9.45 ıj	17.74 ı	48.0 h
Average	6.50	2.82	12.19	46.99	22.20	48.1
L.S.D. (%5)	1.63	0.42		10.11	0.61	0.38

CONCLUSION

The plant height, number of capsules, capsule length, number of seeds per capsule, number of branches, 1000 seed weight, harvest index, seed yield, protein ratio and oil ratio were significantly different among 18 varieties and populations investigated. However, the capsule width was not significantly different among varieties and populations. The highest plant height, first capsule height, number of seeds per capsule, 1000-seed weight and harvest index were obtained with moderate and dark brown seed crust color sesame genotypes.

Higher seed yields were obtained in genotypes which were adopted to the region. The results of our research revealed that moderate and dark sesame seed crust colored varieties can be successfully grown in our region.

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