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Araştırma Makalesi (Research Article)

**Investigation of Change of Yield and Yield Components in Sesame (*Sesamum indicum* L.) According to Years and Locations\*\***

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**Abstract:** This study was carried out to investigate the characteristics of second crop sesame growing in Manisa, Antalya, İzmir, and Şanlıurfa ecological conditions between 2008 and 2012, and to shed light on future studies. Baydar-2001, Muganlı-57, Arslanbey, Özberk-82, Birkan, Orhangazi-99, Hatipoğlu, Boydak and BATEM-Uzun varieties were used as plant material. It seems that the change of ecological environmental conditions has very importance in the second crop sesame cultivation. In this study, while the highest seed yield was obtained from İzmir location, the lowest seed yield was obtained from Şanlıurfa location. It is concluded that Arslanbey and Hatipoğlu varieties will be recommended in Şanlıurfa location and BATEM-Uzun variety in Aegean and Mediterranean locations.

**Susamda Lokasyon ve Yıllara Göre Verim ve Verim Unsurlarının Değişiminin Araştırılması**

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**Anahtar kelimeler**

Lokasyon,  
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Tohum verimi.

**Öz:** Bu çalışma 2008-2012 yılları arasında Manisa, Antalya, İzmir ve Şanlıurfa ekolojik koşullarında yetiştirilen ikinci ürün susam bitkisinin özelliklerini incelemek ve gelecekteki çalışmalara ışık tutmak amacıyla yapılmıştır. Bitki materyali olarak Baydar-2001, Muganlı-57, Arslanbey, Özberk-82, Birkan, Orhangazi-99, Hatipoğlu, Boydak ve BATEM-Uzun çeşitleri kullanılmıştır. Ekolojik çevresel koşullardaki değişimin, ikinci ürün susam yetiştiriciliğinde çok önemli olduğu görülmektedir. Bu çalışmada, en yüksek tohum verimi İzmir lokasyonundan elde edilirken, en düşük tohum verimi Şanlıurfa lokasyonundan elde edilmiştir. Arslanbey ve Hatipoğlu çeşitlerinin Şanlıurfa lokasyonunda ve BATEM-Uzun çeşidinin ise Ege ve Akdeniz bölgelerinde tavsiye edileceği sonucuna varılmıştır.

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**1. Introduction**

The use of sesame seeds dates back to 3000 BC. Archaeological evidence suggests that the sesame plant was the first oil plant to be cultivated. Sesame, which has an important place in the production of vegetable oil in the world, is one of the oil plants having high percentage of oil (50-

60%) and rich protein (20-25%) (Tan, 2011). Although sesame contains 35-45% oleic and linoleic fatty acids which are important for human nutrition, it is used as seed rather than oil industry due to difficulties in harvesting and obtaining seeds and high cost (Arslan et al., 2007; Şahin, 2014). Sesame is also resistant to oxidation compared to other vegetable oils. This feature is reported to be caused by secondary substances such as sesamine (0.5-1.5%) and sesamoline (0.3-0.5%). It is known that it is good for many diseases such as diabetes and anaemia due to its rich content of vitamins and minerals. It is also known to be especially effective in lowering blood cholesterol levels. (Salunkhe et al., 1991).

Sesame is a one-year bush forming plant with a short development period (90-120 days). Water, nutrient demand and soil selectivity is less, hot and drought tolerant. It is also a good crop rotation thanks to the dense fibrous root system. Usually no marketing problem is available in oil crop plant that is grown as main and secondary products in Turkey. The reasons why sesame cultivation is not developed sufficiently; inadequate cultivation techniques (16.89%), inadequate application of fertilization (10.53%), weed problem stemming from especially broadcast sowing (8.99%), marketing (7.89%), pests (3.07%), soil preparation (2.41%), and irrigation (2.19%) (Dizdaroğlu and Tan, 1995; Bakal and Arıoğlu, 2020).

Sesame, which is mostly grown as second crop in the southern and south-eastern regions of Turkey, makes significant contributions to the national economy thanks to optimum land use. Harvest is done by hand due to the loss of productivity caused by machine harvesting. This creates temporary employment area in the harvest period.

According to the data of 2019; in the world, sesame cultivation area is 9.9 million ha, production is 5.5 million tons and yield is 554 kg ha<sup>-1</sup> (FAOSTAT, 2019). In Turkey, sesame cultivation area of 25 985 ha, is given as 17 437 tons of production and yield 670 kg ha<sup>-1</sup> (TURKSTAT, 2019). Sesame cultivation in Turkey respectively; Manisa, Antalya, Uşak, Muğla, and Adana provinces are made intensively. The cultivation areas of these provinces constitute approximately 77% of the total cultivation areas. When examined in terms of yield, it is seen that the average of the provinces which are cultivated intensively is 780 kg ha<sup>-1</sup> and above the world average.

In sesame seed, Turkey is an importer. Sesame seeds worthy of approximately 156 million dollars are imported. 85% of our total sesame imports are from Nigeria, Sudan, Chad, and Ethiopia. Almost 50% of Turkey's imports are made from Nigeria with the amount of 46 thousand tons (TURKSTAT, 2019).

This study was carried out in order to investigate some of the important features of second crop sesame production in Manisa, Antalya, İzmir, and Şanlıurfa between 2008 and 2012, and to shed light on future studies.

## 2. Materials and Methods

In this study, the data published by Ankara Seed Registration and Certification Centre Directorate were used. Experiments were established in Manisa, Antalya, İzmir and Şanlıurfa provinces where the cultivated areas are dense, and seed yield (kg da<sup>-1</sup>), plant height (cm), days to physiological maturity (days), 50% flowering days (days), capsule number (per plant) and branch number (per plant) properties were examined between 2008-2012. As plant material, Baydar-2001, Muganlı-57, Arslanbey, Özberk-82, Birkan, Orhangazi-99, Hatipoglu, Boydak and BATEM-Uzun varieties were used (Table 1). Information about the varieties is given in Table-1. The adjusted data were obtained from the raw data by taking the year\*location as a block according to the Augmented Designs with the help of the equation given below (Peterson, 1985).

$$\text{Adjusted Data} = \text{Raw Data} + \frac{(\text{Sum Block} - \text{Sum Means St Varieties})}{(\text{St Varieties Numbers})}$$

The maximum temperature changes of the locations are given in Fig.1 and humidity changes are given in Fig.2.

Table 1. Information on varieties of sesame (*Sesamum indicum* L.) used as material.

Varieties	Company/Institute	Origin	Reg. Date
Arslanbey	GAP Agricultural Research Institute	Turkey	15.04.2010
BATEM-Uzun	Western Mediterranean Agricultural Research Institute	Turkey	10.04.2013
Boydak	GAP Agricultural Research Institute	Turkey	11.04.2012
Birkan	Akdeniz University Faculty of Agriculture	Turkey	06.04.2011
Baydar-2001	Western Mediterranean Agricultural Research Institute	Turkey	25.04.2001
Hatipoğlu	GAP Agricultural Research Institute	Turkey	11.04.2012
Muganlı-57	Western Mediterranean Agricultural Research Institute	Turkey	28.04.1986
Orhangazi-99	Aegean Agricultural Research Institute	Turkey	28.04.1999
Özberk-82	Western Mediterranean Agricultural Research Institute	Turkey	28.04.1986

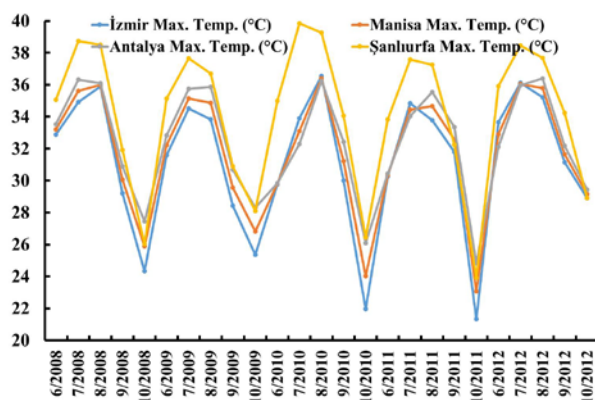


Figure 1. Maximum temperature changes of locations (data of General Directorate of Meteorology).

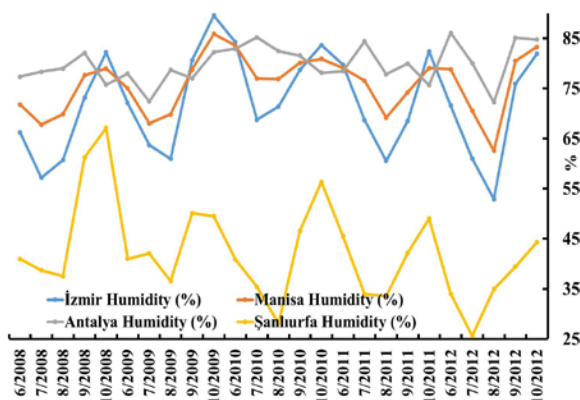


Figure 2. Maximum humidity changes of locations (data of General Directorate of Meteorology).

### 3. Results

When seed-yield characteristic is examined in terms of years-locations 44.58-197.38 kgda<sup>-1</sup> changes, the average is 86.45 kgda<sup>-1</sup>; between locations 70.71-123.91 kg da<sup>-1</sup>; and the years 49.96-108.27 kg da<sup>-1</sup> is seen to change. The highest seed-yield was obtained from İzmir location and the lowest seed-yield was obtained from Şanlıurfa location. The highest seed-yield was obtained in 2012 and the lowest in 2009 (Table 3). The climate values of 2009 are quite negative in terms of sesame production. When the seed yields of the location averages of the varieties were examined; Arslanbey (109.25 kg da<sup>-1</sup>) was obtained the highest seed-yield, while Orhangazi-99 (68.18 kgda<sup>-1</sup>) variety had the lowest seed-yield (Table 2). High seed-yield values in İzmir, Manisa, and Antalya locations, where Aegean and Mediterranean climates prevail, indicate that high temperature may have adversely affected the seed-yield of sesame.

When the years-locations examined in terms of plant height feature; 96.42-178.23 cm varies, the average is 129.38 cm; between locations 116.82-143.10 cm and years 108.56-147.56 cm is seen that changes. The highest plant height value was obtained from Manisa location and the lowest plant height was obtained from Antalya location. The highest plant height was obtained from 2010, while the lowest plant height was obtained from 2009 (Table 3).

When the years-locations were examined in terms of days to 50% flowering days (day); 28.67-75.60 days, average 38.79 days; between locations 31.14-45.97 days; the years 35.33-44.80 days, the same change is clear. The highest days to 50% flowering days (day) were obtained from the Antalya location and the lowest days to 50% flowering days (day) were obtained from the Manisa location. The highest days to 50% flowering days (day) was obtained in 2012, while the lowest number was obtained in 2009 (Table 3).

Table 2. Average seed yield values of varieties by Location (kg da<sup>-1</sup>)

Varieties	Antalya	Manisa	İzmir	Şanlıurfa (Koruklu)	Şanlıurfa (Tektek)	Means
BATEM-Uzun	117.13	120.41	176.98	38.59	15.59	93.74 b
Boydak	67.10	108.95	137.17	100.50	116.05	105.95 a
Birkan	71.29	79.40	85.04	60.22	45.08	68.21 d
Baydar-2001	80.43	85.36	136.68	62.06	54.89	83.88 c
Hatipoğlu	62.15	64.00	130.14	104.81	117.59	95.74 b
Arslanbey	69.06	91.79	123.31	133.69	128.38	109.25 a
Muganlı-57	64.02	82.56	80.03	68.27	60.81	71.14 d
Orhangazi-99	69.18	69.38	129.12	38.17	34.90	68.15 d
Özberk-82	76.04	89.41	116.76	64.43	63.11	81.95 c
Means	75.16 c	87.92 b	123.91 a	74.53 c	70.71 c	

Varieties LSD<sub>5%</sub>: 9.50 kg da<sup>-1</sup>; Location LSD<sub>5%</sub>: 11.32 kg da<sup>-1</sup>

When the years-locations were examined in terms of the days to physiological maturity (days), 90.00-121.88 days showed a change, while the average was 101.71 days; i.e. a change between locations 97.22-100.94 days and between the years 99.50-105.93 days are observed. The highest days to physiological maturity (days) was obtained from Manisa location and the lowest day to physiological maturity (days) was obtained from İzmir location. The highest day to physiological maturity (days) was obtained in 2008 and the lowest in 2010 (Table 3).

When the years-locations were examined in terms of the capsule number (per plant), it was found that 55.00-337.86 (per plant) changes and average 142.84 (per plant), between locations 88.63-236.34 (per plant) and the years 95.67-159.80 (per plant) is seen to change. The highest capsule number (per plant) was obtained from Manisa location and the lowest one was obtained from Antalya location. The highest capsule number (per plant) was obtained from 2012, while the lowest one was obtained from 2010 (Table 3).

When the years-locations were examined in terms of the capsule number (per plant), it was found that 55.00-337.86 (per plant) changes and average 142.84 (per plant), between locations 88.63-236.34 (per plant) and the years 95.67-159.80 (per plant) is seen to change. The highest capsule number (per plant) was obtained from Manisa location and the lowest one was obtained from Antalya location. The highest capsule number (per plant) was obtained from 2012, while the lowest one was obtained from 2009 (Table 3).

When the yields of all varieties are evaluated on the basis of locations; the highest seed-yield was obtained from İzmir location with 176.98 kgda<sup>-1</sup>, and the lowest seed-yield was obtained from BATEM-Uzun variety with Şanlıurfa (Tektek) location with 15.59 kgda<sup>-1</sup>. Antalya location, the highest seed-yield 117.13 kgda<sup>-1</sup> with the BATEM-Uzun variety, the lowest seed-yield 62.15 kg da<sup>-1</sup> with the Hatipoglu variety was obtained. Manisa (Beydere) location, the highest seed-yield 120.41 kg da<sup>-1</sup> BATEM-Uzun variety, the lowest seed-yield 64.00 kg da<sup>-1</sup> with Hatipoglu variety, was obtained. The lowest seed-yield was obtained from Muganlı-57 variety with 80.03 kg da<sup>-1</sup> and the highest yield from BATEM-Uzun variety with 176.98 kg da<sup>-1</sup>. Şanlıurfa (Koruklu) location, the lowest seed-yield 38.17 kg da<sup>-1</sup> with the Orhangazi-99 variety, the highest seed-yield 133.69 kg da<sup>-1</sup> was obtained from the Arslanbey variety. Şanlıurfa (Tektek) location, the lowest seed-yield 15.59 kg da<sup>-1</sup> with the BATEM-Uzun variety, the highest seed-yield 128.38 kg da<sup>-1</sup> with the Arslanbey variety was obtained (Table 3).

Table 3. Location and years values of the traits examined

Traits	Locations						Means
	Years	Antalya	Manisa	İzmir	Şanlıurfa (Koruklu)	Şanlıurfa (Tektek)	
Seed yield (kg da <sup>-1</sup> )	2008	75.33	81.18	90.00	108.79	99.29	90.92
	2009	44.58	54.92	44.28	59.58	46.42	49.96
	2010	65.21	109.98	127.88	86.38	71.91	92.27
	2011	84.00	90.62	160.01	53.51	65.94	90.81
	2012	106.71	102.90	197.38	64.37	70.00	108.27
	Means	75.16	87.92	123.91	74.53	70.71	86.45
Plant height (cm)	2008	123.50	130.75	125.00	134.25	118.75	126.45
	2009	110.00	113.02	98.48	124.87	96.42	108.56
	2010	121.79	153.76	146.01	178.23	138.01	147.56
	2011	114.00	158.16	133.76	104.07	123.87	126.77
	2012	114.80	159.80	160.50	125.72	127.00	137.56
	Means	116.82	143.10	132.75	133.43	120.81	129.38
Days to 50% flowering days (day)	2008	47.25	32.75	40.40	40.25	40.50	40.23
	2009	35.00	28.67	33.17	40.00	39.83	35.33
	2010	38.00	29.50	37.13	41.25	39.25	37.03
	2011	34.00	32.57	33.00	41.57	41.57	36.54
	2012	75.60	32.20	33.60	41.60	41.00	44.80
	Means	45.97	31.14	35.46	40.93	40.43	38.79
Days to physiological maturity (days)	2008	102.50	121.25	92.00	90.00	91.75	99.50
	2009	101.00	119.33	97.00	97.67	97.33	102.47
	2010	105.00	121.88	102.88	101.25	98.63	105.93
	2011	101.00	108.00	92.43	101.57	102.43	101.09
	2012	95.20	99.20	101.80	101.60	100.00	99.56
	Means	100.94	113.93	97.22	98.42	98.03	101.71
Capsule number (per plant)	2008	73.75	225.50	155.00	174.75	146.00	155.00
	2009	98.00	147.50	87.17	90.67	55.00	95.67
	2010	94.00	183.63	197.13	97.00	197.13	153.78
	2011	95.00	337.86	166.86	64.57	85.43	149.94
	2012	82.40	287.20	227.00	92.40	110.00	159.80
	Means	88.63	236.34	166.63	103.88	118.71	142.84
Branch Number (per plant)	2008	2.50	6.00	4.60	4.00	3.75	4.17
	2009	4.50	6.00	4.83	3.50	3.33	4.43
	2010	3.88	5.00	5.63	3.38	3.88	4.35
	2011	4.35	5.86	6.29	2.70	2.53	4.34
	2012	3.20	5.80	5.40	2.80	4.30	4.30
	Means	3.69	5.73	5.35	3.28	3.56	4.32

#### 4. Discussion and Conclusion

It is thought that sesame genotypes show different responses in different environmental conditions and show ecological performance due to the genetic structure of the genotypes. This situation reveals the necessity of determining the performances of lines/varieties according to environmental conditions and suggesting different genotypes to different environments. Thus, the best result can be obtained from the genotype showing good performance according to ecological environmental conditions. As in many field crops, studies to determine the environmental performance of new lines in sesame plants are of great importance in terms of production and efficiency. It has been determined that environmental conditions, which have changed over the years, greatly affect sesame performance. It has been revealed that the ecological conditions of Izmir differ greatly from the other ecological conditions studied. Our findings in terms of seed yield characteristics are similar to the findings of Cürat (2010), Ulukütük (2011), Dossa et al. (2019), and Bakal and Arıoğlu (2020).

High seed-yield values of BATEM-Uzun variety were obtained especially in Aegean and Mediterranean regions, but low seed-yield values were obtained in Şanlıurfa location. Arslanbey and Hatipoğlu varieties were obtained in Şanlıurfa locations with high seed-yield values. In this case,

Arslanbey and Hatipoglu varieties in Şanlıurfa location and BATEM-Uzun variety in Aegean and Mediterranean locations are recommended.

The second crop is in sesame cultivation, change of ecological environmental conditions is quite important; the highest seed-yield was obtained from İzmir location, and the lowest seed-yield was obtained from Şanlıurfa location. It is concluded that Arslanbey and Hatipoglu varieties will be recommended in Şanlıurfa location, and BATEM-Uzun variety in Aegean and Mediterranean locations.

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