

Doğu Akdeniz İklim Koşullarında Tescilli Nohut (*Cicer arietinum L.*) Çeşitlerinin Adaptasyonu ve Kalite Değerlerinin Araştırılması

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ÖZ

Bu araştırma Türkiye’de tescil edilmiş on nohut çeşidi (Diyar-95, Arda, Botan, Aksu, Aslanbey, Ubet, Sezgin, Caner, Onur01 ve Azkan) ile Doğu Akdeniz Adana ekolojik şartlarında verim ve kalite unsurlarını belirlemek amacıyla 2022 ve 2023 yıllarında yapılmıştır. Denemeler, Tesadüf Blokları Deneme desenine göre üç tekerrürlü olarak yürütülmüştür. Çalışmada çeşitlerin, tane verimi, yüz tane ağırlığı, bitki boyu, %50 çiçeklenme süresi ve kalite parametreleri incelenmiştir. Araştırma bulgularına göre çeşitlerin çiçeklenme süresi 76.75-84.25 gün değerleri arasında, Botan-Aslanbey çeşitlerinden; bitki boyu 53.04-60.67 cm değerleri arasında Sezgin-Azkan çeşitlerinden; yüz tane ağırlığı 38.70-49.07 g değerleri arasında Diyar-95-Aslanbey çeşitlerinden; tane verimi 175.70-286.42 kg/da değerleri arasında Sezgin-Aslanbey çeşitlerinden elde edilmiştir. Araştırma sonunda elde edilen veriler göre tane verimi yönünden en yüksek değere sahip olan Aslanbey, Onur01, Ubet, Botan, Diyar-95, Aksu ve Arda çeşitleri bölge için tavsiye edilebilir çeşitler olarak tespit edilmiştir. Ancak daha sağlıklı karar verebilmek için daha uzun yıllar, ayrıntılı agronomik çalışmalarla desteklenerek tarla çalışmaların yapılması gerekmektedir.

Anahtar kelimeler: Nohut, Adaptasyon, Verim, Kalite

The Research on The Adaptation and Quality Values of Registered Chickpea (*Cicer arietinum L.*) Varieties Under Eastern Mediterranean Climatic Conditions

ABSTRACT

This research was carried out in 2022 and 2023 with ten chickpea varieties (Diyar-95, Arda, Botan, Aksu, Aslanbey, Ubet, Sezgin, Caner, Onur01 and Azkan) registered in Turkey to determine yield and quality factors under Eastern Mediterranean Adana ecological conditions. The experiments were carried out according to the Randomized Block Design with three replications. In the study, grain yield, hundred grain weight, plant height, 50% flowering time and quality parameters of the varieties were analyzed. According to the findings of the research, flowering period of the varieties was between 76.75-84.25 days for Botan-Aslanbey varieties; plant height was between 53.04-60.67 cm for Sezgin-Azkan varieties; hundred grain weight was between 38.70-49.07 g for Diyar-95-Aslanbey varieties; grain yield was between 175.70-286.42 kg/da for Sezgin-Aslanbey varieties. According to the data obtained at the end of the research, Aslanbey, Onur01, Ubet, Botan, Diyar-95, Aksu, and Arda varieties, which had the highest values in terms of grain yield, were found to be recommended varieties for the region. However, in order to make a better decision, field studies should be carried out for longer years supported by detailed agronomic studies.

Key words: Chickpea, Adaptation, Yield, Quality

INTRODUCTION

Chickpea has an important place in human nutrition especially in developing countries because it is rich in protein. In addition, because it is not selective in terms of soil requirements and gives good yields in arid and semi-arid areas, it is of great importance in cereals-edible legumes alternation. Chickpea plant is among the most produced edible grain legumes in our country because it is a plant that can withstand heat and drought the most after lentils and can grow in soils weak in terms of nutrients (Şahin and Geçit, 2006). The importance of chickpea plant in the world is increasing; because the economic importance of protein-rich chickpea is increasing due to the pressure of drought stress with global warming. Among legumes, chickpea plant is a prominent plant in human nutrition due to its richness in protein, vitamins and minerals and energy content. While it is an important edible grain legume, it also constitutes the raw material of the chickpea industry. For this reason, it is of sociological importance as well as economic importance for some regions of our country (Çeker, 2008). The data for chickpea for the year 2022 shows a cultivation area of 456.480 ha in Turkey, a production of 580.000 tons and a grain yield of 127.00 kg/ha (Anonim, 2024). Anthracnose blight disease is the most important factor limiting chickpea cultivation areas in the world and in our country. The climate of the Mediterranean region is suitable for winter cultivation of chickpea plants, but yield losses are observed in late spring sowing due to high temperatures. With the preference of chickpeas suitable for winter cultivation and registered varieties tolerant to diseases, it has become possible to plant earlier and to obtain higher quality and high yielding products. Due to global warming, climates change from year to year, precipitation decreases and the danger of drought arises. In recent years, with the increase in temperature, seasonal shifts in growing periods are observed in planting seasons. It is known that there are shifts in the spring seasons in the middle and high latitudes of the northern hemisphere due to global warming, and it is observed that the summers are longer and drier (Peñuelas & Filella, 2001; Walther et al., 2002; Craufurd & Wheeler, 2009). Many varieties have been developed as a result of chickpea breeding studies in our country. However, breeding programs are carried out in different ecological conditions to develop varieties resistant to yield, quality and stress conditions. Therefore, the importance of developing varieties that are tolerant to diseases and resistant to extreme heat and drought increases with breeding programs. The aim of this study is to investigate the performances, grain yield and quality values of the registered chickpea varieties that have found commercial value as well as breeding studies in winter sowing for the Mediterranean region and to evaluate the possibilities of cultivation under regional conditions.

MATERIAL AND METHOD

This research was conducted in two different growing years (2022-2023) in the experimental field at Adana-Doğankent location in the Eastern Mediterranean region. The research experiment was established according to the randomized block design with three replications. The plots were planned as 4 rows (5 m X 4 rows X 0,45 m) of 9 m² with 45 cm between rows and 8 cm above rows, and fertilizer was applied as 3 kg/da N and 6 kg/da P₂O₅ in both years with planting.

Doğankent locality, where the trials were planted in this study, is located at (37°00' N, 35°20' E) latitude and longitude coordinates and has alluvial soils in terms of soil structure. Çukurova region is a delta plain formed by the alluvium carried by Seyhan, Ceyhan and Tarsus rivers. The soils in the test area are loamy and have a slightly alkaline reaction. They are medium in organic matter, poor in nitrogen and phosphorus, but rich in potassium (Table 1).

Table 1. Eastern Mediterranean Agricultural Research Institute Experimental Area Soil Analysis Report

Depth (cm)	Saturation (%)	pH	E.C. (dS/m)	Lime (%)	P ₂ O ₅ (kg/da)	organic matter (%)	volume weight (g/cm ³)	Field capacity %	% Fade point	% Clay	% Silt	% Sand	Composition
0-25	52,8	7,78	0,48	16,72	1,9	1,11	1,48	29,74	18,76	30,9	43,3	25,9	CL
25-50	51,7	7,75	0,50	20,00	0,9	0,60	1,57	28,68	17,88	28,7	45,3	25,9	CL
50-75	57,2	7,78	0,34	25,24	0,7	0,31	1,46	31,51	18,93	35,1	45,5	19,4	SiCL
75-100	50,6	7,92	0,59	22,95	0,3	0,34	1,52	28,87	14,74	26,5	43,0	30,5	L

E.C.: salinity; O.M.: Organic matter; H.A.: Volume weight; T.K.: Field capacity; S.N: Fading point

The experimental area is under the influence of Mediterranean climate and meteorological data are given in Table 2. When the temperature averages of the years in which the experiments were carried out are examined, it is observed that although values close to the long-term average in terms of temperature, the temperature values in July in both growing years showed values above the long-term average. When the precipitation values are analyzed according to the years, irregularities in precipitation distribution and periodic intensities in precipitation amounts have been experienced in recent years due to global warming. As a result,

stresses (rotting due to drought or excessive rainfall, root diseases, etc.) are observed in plants. In the 2022 and 2023 growing years, it is observed that the rainfall amounts are low compared to the long years and their distribution is irregular. Drought stress was observed especially in 2022. Relative humidity rates showed values parallel to long years.

Table 2. Adana province 2021-22; 2022-23 and long years climate values

Months	Average Temperature (C°)			Rainfall (mm)			Relative humidity (%)		
	Long Years (1982-2021)	2021-22	2022-23	Long Years (1982-2021)	2021-22	2022-23	Long Years (1982-2021)	2021-22	2022-23
December	10,43	11,5	11,2	121,48	6,91	24,7	68,67	68,26	68,53
January	9,05	10,2	9,9	109,01	5,07	16,0	67,69	67,19	63,65
February	10,15	11,5	8,62	81,87	2,48	61,1	65,68	70,97	58,89
March	13,14	12,7	14,86	63,08	2,31	81,4	66,74	60,04	67,09
April	17,27	18,3	17,14	49,67	2,6	47,5	68,02	57,2	66,08
May	21,40	23,9	21,55	42,15	1,0	42,2	68,03	61,7	61,27
June	25,17	25,8	23,72	13,97	12,8	0,0	69,01	72,7	67,50
July	27,08	29,4	36,32	7,46	0	2,00	69,94	66,2	62,15
Total				488,69	33,17	274,9			

FINDINGS AND DISCUSSION

This research was carried out in the experimental field of Adana-Doğankent in the growing years 2022-2023 by sowing in December during the winter sowing period. In this study, the highest grain yield values obtained from chickpea varieties in 2022 varied between 356.3-334.2 kg/da and Aslanbey, Onur01 and Diyar-95 chickpea varieties were examined in the same group. The lowest grain yield was obtained from Azkan variety with 209 kg/da. In 2023, the highest grain yield varied between 227-213 kg/da and Ubet, Botan, Aslanbey, Aksu, Arda, Diyar-95 and Azkan varieties were examined in the same group. The lowest grain yield was obtained from Sezgin variety with 107.1 kg/da. The general yield average of the varieties was determined as 303.7 kg/da in 2022 and 199.7 kg/da in 2023. The lowest grain yield was obtained from Sezgin variety with 175.70 kg/da and the highest grain yield was obtained from Aslanbey variety with 286.42 kg/da in the two-year combined average values of chickpea varieties; the general average of the combined year and varieties was 251.55 kg/da (Table 3). Doğan et al. (2023) conducted a study in 2019-2020 to determine the yield and yield parameters of 12 registered chickpea varieties at Kızıltepe and Bozova locations; number of days to emergence, days to flowering, plant height, first pod height, number of branches, number of pods, number of grains, 100 grain weight, grain yield, biological yield, harvest index and protein ratio were examined. According to the results obtained, Hasanbey and Arda stood out in terms of grain yield and protein content, respectively. Mishra et al. (2002) reported that the number of pods in a plant was the character with the highest positive effect on seed yield. Grain yield may vary depending on factors such as cultivation technique, climate and soil conditions and genetic structure of chickpea.

Table.3. Grain Yield (kg/da) and 100 Grain Weight (g) Values of Some Registered Chickpea Varieties

Varieties	Yield (kg/da)			100 Grain Weig (g)		
	2022	2023	Combined Average	2022	2023	Combined Average
DIYAR-95	334,2 a	213,1 a	273,61 ab	40,03 c	37,4 e	38,70 d
ARDA	307,7 a-c	215,8 a	261,78 ab	41,9 c	36,8 e	39,35 d
BOTAN	329,1 ab	223,6 a	276,33 ab	45,9 b	41,8 cd	43,82 c
AKSU	318,7 ab	222,6 a	270,64 ab	45,3 b	43,4 b-d	44,35 bc
ASLANBEY	356,3 a	216,5 a	286,42 a	53,3 a	44,8 ab	49,07 a
UBET	327,2 ab	227,1 a	277,14 ab	48,1 b	44,1 a-c	46,11 ab
SEZGIN	272,1 bc	107,1 c	175,70 c	41,9 c	38,6 e	40,25 d
CANER	248,2 cd	153,1bc	200,67 bc	47,9 b	41,5 d	44,74 bc
ONUR01	355,8 a	197,1ab	277,85 ab	53,1 a	44,3 a-c	48,71 a
AZKAN	209,3 d	221,4 a	215,39 a-c	47,9 b	46,5 a	47,22 ab
Average	303,37	199,73	251,55	46,55	41,92	44,23
MIN	179,56	31,33	31,33	37,88	34,81	34,81
MAX	429,11	310,44	429,11	54,56	48,37	54,56
Coefficient of variation (%)	13,9	17,2	19,16	3,3	2,59	4,61

* 5% significant level, ** 1% significant level

In terms of 100 grain weight, for the year 2022, Onur01 and Aslanbey varieties stood out with the largest grain weight of 53.3 g; for the year 2023, Azkan with 46.5 g and Onur01, Aslanbey and Ubet varieties with 44 g stood out in Adana. When we look at the 100 grain weight of the registered varieties included in the trial, the average 100 grain weight of Adana location was 46.6 g in 2022 and 41.9 g in 2023. In the combined average values of chickpea varieties for two years, the lowest 100 grain weight of Diyar95 (38.70 g) and the highest 100 grain weight of Aslanbey (49.07 g) varieties; the general average of the combined year and varieties was 44.23 g (Table 3). The most important factor in price formation in the market is the cleanliness and grain size of the product. Generally, large grain products are sold at higher prices. Another issue as important as grain size in variety development is that grain size should be as homogeneous and stable as possible. Because at the marketing stage and before packaging, the grains are separated by selecting them according to their size in order to make them conform to the standard (Atmaca, 2008). In the ecological conditions of Adana, during the winter planting, the lowest and highest plant height values for chickpea varieties in 2022 were obtained from the Sezgin variety with 56.5 cm and from the Azkan variety with 66.75 cm, respectively. In 2023, the lowest plant height was recorded for the Botan variety with 48.33 cm, while the highest was for the Onur01 variety with 56.25 cm. The average plant height for the varieties was 62.23 cm in 2022 and 52.16 cm in 2023. In the combined two-year average plant height values for the chickpea varieties, the lowest heights were recorded for the Botan and Sezgin varieties with 53 cm, while the highest plant heights were recorded for the Azkan, Onur01, and Diyar-95 varieties with 60.67 cm. The overall average plant height for the combined years and varieties was 57.19 cm (Table 4). In chickpea farming, plant height and the height of the first pod are the most important parameters representing suitability for mechanical harvesting (Mart et al., 2017). In terms of agronomic traits, the high plant height of chickpea plants shows suitability for machine harvesting by reducing grain loss. Ceyhan et al. (2007) showed that the plant height of chickpea genotypes varied between 33.1 - 44.1 cm in Konya ecological conditions. In another study, Ceyhan et al. (2013) found that the plant height of chickpea genotypes varied between 39.0 and 60.2 cm under Konya conditions. Although the plant height values obtained by the researchers are similar to the values obtained in this study, sowing time has an effect on plant height. Higher plant height values were obtained in winter sowing compared to summer sowing.

Table.4. Plant Height (cm) and Days to 50% Flowering (days) in Some Registered Chickpea Varieties

Varieties	Plant Height (cm)			50% Flowering (days)		
	2022	2023	Combined Average	2022	2023	Combined Average
DİYAR 95	66,25	54,16	60,21	70,00	95,75	82,88ab
ARDA	60,50	54,16	57,33	70,50	93,25	81,88ab
BOTAN	58,00	48,33	53,17	66,00	87,50	76,75c
AKSU	59,00	50,41	54,71	68,75	91,75	80,25b
ASLANBEY	63,75	50,00	56,87	72,25	96,25	84,25a
UBET	62,50	51,25	56,87	68,75	91,75	80,25b
SEZGİN	56,50	49,58	53,04	68,75	93,75	81,25ab
CANER	65,00	52,91	58,96	69,00	96,25	82,63ab
ONUR01	64,00	56,25	60,12	72,25	95,00	83,63a
AZKAN	66,75	54,58	60,67	72,25	95,00	83,63a
Average	62,23	52,16	57,19	69,85	93,63	81,74
MIN	56,50	48,33	53,04	68,75	87,50	76,75
MAX	66,75	56,25	60,21	72,25	96,25	84,25
Coefficient of variation (%)	1,46	5,70	9,44	2,72	3,20	2,43

* 5% significant level, ** 1% significant level

In Adana location, the lowest number of days to 50% flowering values of chickpea varieties in winter sowing were obtained from Botan variety with 66 days in 2022 and the highest were obtained from Onur01, Aslanbey, Azkan varieties with 72.25 days. In 2023, the lowest was obtained from Botan variety with 87.50 days and the highest was obtained from Caner, Aslanbey varieties with 96.25 days. The average number of days to 50% flowering was 69.85 days in 2022 and 93.63 days in 2023. The lowest number of days to 50% flowering was obtained from Botan variety with 76.75 days and the highest number of days to 50% flowering was obtained from Aslanbey variety with 84.25 days in the two-year combined mean values of chickpea varieties; the overall mean value of the combined year and varieties was 81.8 days (Table 4).

In chickpea farming, days to 50% flowering values represent the most important parameters indicating whether chickpea varieties are early or late (Mart et al., 2017). In terms of agronomic traits, fifty percent days to flowering values of chickpea plants indicate the earliness of the varieties. In the studies conducted with days

to 50% flowering values, Aydoğan (2012) found that the number of days to 50% flowering varied between 59.0-67.3 days and Karakan (2014) found that it varied between 57.0-62.3 days.

Table.5. Artificial Epidemic (1-9) Anthracnose (*Ascochyta rabiei* (Pass. Labr.)) in Some Registered Chickpea Varieties Disease Observations

Varieties	Ascochyta Blight (<i>Ascochyta rabiei</i> (Pass. Labr.)) Artificial Epidemic (1-9)			
	2022		2023	
	ANKARA	ESKİŞEHİR	ANKARA	ESKİŞEHİR
DIYAR-95	5	6	7	6
ARDA	4	5	4	5
BOTAN	5	6	6	5
AKSU	5	4	6	5
ASLANBEY	4	6	6	5
UBET	6	5	7	5
SEZGİN	3	5	7	5
CANER	4	4	6	5
ONUR01	5	5	7	5
AZKAN	5	5	6	5

In 2022, varieties were tested for anthracnose disease under artificial epidemic conditions in Ankara and Eskişehir locations. Under artificial epidemic conditions, Ubet was the most susceptible variety with a score reading of 6 in Ankara and Aslanbey, Diyar95 and Botan were the most susceptible varieties with a score reading of 6 in Eskişehir. In Eskişehir location, the most tolerant varieties were Aksu and Caner (Table 5).

In 2023, varieties were tested for anthracnose disease under artificial epidemic conditions in Ankara and Eskişehir. Under artificial epidemic conditions, Diyar 95, Ubet, Onur01 and Sezgin were the most susceptible varieties in Ankara with a score of 7, while Diyar 95 was the most susceptible variety in Eskişehir with a score reading of 6. Arda was the most tolerant variety in Ankara (Table 5).

The occurrence of *Ascochyta blight* disease has a negative effect on hundred grain weight, average grain size values and yields, causing yield losses and decreasing hundred grain weight. Chickpea varieties to be planted for winter should have high tolerance/resistance to winter and *Ascochyta blight* disease (Nalçacı et al., 2021, Kocalar et al., ng factors limiting the yield in chickpea agriculture, and it is reported that the yield to be obtained from winter plantings can be increased by 60% to 130% compared to summer plantings by using varieties resistant to Anthracnose.

In Adana location, the average hundred grain weight values obtained for chickpea varieties in winter sowing were 39.7 g in 2022 and 42.8 g in 2023; water absorption capacity was 0.485 g / grain in 2022 and 0.481 g / grain in 2023; Swelling index was 2.33% in 2022 and 2.21% in 2023; cooking time was 63 min and 54 min; protein was 23.5% in 2022 and 24.9% in 2023; sieve values were 8.2 mm in 2022 and 8.3 mm in 2023. The lowest and highest average crude protein values of the varieties were determined as Ubet with 22% and Azkan with 24.6% in 2022; Azkan with 23.9% and Aslanbey with 26.6% in 2023 (Table 6).

Table.6. Results of analysis of quality values of chickpea Genotype/varieties in winter sowing

Varieties	Dry Weight (100 grain) (g)		Water Intake Capacity (g/grain)		Water Intake Index (%)		Cooking time (minutes)		Protein (%)		Sieve value (mm)	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
	DIYAR 95	37,3	36,0	0,457	0,379	2,33	2,06	52	51	23,1	25,3	8,0
ARDA	34,6	37,9	0,416	0,429	2,34	2,09	53	57	23,9	25,2	7,9	7,9
BOTAN	39,9	43,7	0,503	0,510	2,33	2,26	72	54	23,0	24,5	8,3	8,5
AKSU	44,4	44,8	0,558	0,516	2,35	2,35	71	56	22,4	24,2	8,3	8,4
ASLANBEY	43,8	46,1	0,522	0,542	2,51	2,27	69	55	24,4	26,6	8,4	8,7
UBET	40,5	45,6	0,486	0,478	2,35	2,15	61	43	22,0	24,9	8,3	8,5
SEZGİN	37,3	37,3	0,455	0,434	2,14	2,25	58	47	23,1	23,9	7,9	8,1
CANER	38,0	46,8	0,484	0,513	2,25	2,17	60	52	24,5	24,7	8,1	8,6
ONUR01	39,2	47,7	0,485	0,556	2,39	2,34	74	61	24,3	25,5	8,1	8,7
AZKAN	42,1	41,8	0,479	0,452	2,28	2,14	63	63	24,6	23,9	8,3	8,0
Average	39,7	42,8	0,485	0,481	2,33	2,21	63	54	23,5	24,9	8,2	8,3

Kahraman et al. (2016) examined the relationships between important quality elements in chickpea grain and the direct and indirect effects of other quality parameters on protein content. As a result of the statistical analysis, a significant-negative (-0.8030**) relationship was found between protein content and nitrogen-free substances, while a significant-positive (0.7535*) relationship was found between protein content and sulfur content. It was concluded that in future studies on protein ratio, fat ratio, boron content, phosphorus content and nitrogen-free extracts ratio should be emphasized. After animal proteins, the highest

vegetable protein is found in edible grain legumes. Depending on the variety and environment, they contain 18-36% protein (Özdemir, 2002; Çiftçi et al., 2004). High values obtained for the parameters of swelling capacity, swelling index, water absorption capacity, water absorption index, wet volume and wet weight, which are technological quality characteristics of chickpea grains, are desired by industrialists and consumers (Gülümser et al., 2008; Erol et al., 2023). Although there is a wide variation among chickpea varieties in terms of the chemical structure and composition of the grain, it has been reported that climate, soil structure, soil nutrient content, agronomic practices, living and non-living stress factors and heredity are effective on the chemical composition of the grain (Adak, 2021; Erol et al., 2023).

CONCLUSION

As a result of the studies conducted with the registered varieties used in the trial, it was observed that some varieties stood out in terms of their suitability for the ecology of the region. In terms of grain yield, Diyar-95 (213-334 kgda) and Aslanbey (217-356 kgda) chickpea varieties were remarkable in terms of yield performance in both years. Grain yields of some varieties were low due to the low amount of rainfall during the vegetation period in the years of the study. In terms of 100 grain weight, Azkan (46,5 g) in the first year and Onur01 and Aslanbey varieties with 53 g in the second year stood out. The average values of plant height of the varieties were 52 cm in the first year and 62 cm in the second year and it was observed that the varieties used in this study were suitable for machine harvesting. In order to improve chickpea cultivation in the region, these studies should be repeated for a long period of time and agronomic studies should be carried out with the prominent chickpea varieties (Diyar-95, Aslanbey and the regional variety Onur01) and the results should be evaluated according to the regional conditions. As a result, it was determined that Diyar-95, Aslanbey and Onur01 chickpea varieties were more prominent than the other varieties in the years studied under Adana ecological conditions.

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