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THE EFFECT OF HARVESTING DATES ON SOME AGRONOMIC AND QUALITY CHARACTERISTICS OF PEANUT (*Arachis hypogaea* L.) VARIETIES GROWN AS A MAIN CROP IN MEDITERRANEAN REGION (TURKEY)

Halis ARIOGLU[1], Halil BAKAL[1], Leyla GULLUOGLU[1], Bihter ONAT[2], Cemal KURT[1]*

[1]Cukurova University, Faculty of Agriculture, Department of Field Crops, Adana, TURKEY
[2]Cukurova University, Vocational School of Kozan, Adana, TURKEY
**Corresponding author: halis@cu.edu.tr*
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ABSTRACT

This study was conducted at the experimental area of the Department of Field Crops, Faculty of Agriculture, Cukurova University as a main crop in 2015 and 2016. The objective of this study was to determinate the effect of harvesting dates on some agronomic and quality characteristics of peanut (*Arachis hypogaea* L.*)* varieties grown as a main crop in Mediterranean region (Turkey). The experimental design was a split plot with three replications. The Halisbey, Sultan, Arioglu-2003, Osmaniye-2005, NC-7, Batem-5025, Flower-22, Flower-32, Flower-36, Brantley and Wilson peanut varieties (Virginia market type) were used as a plant material in this research. The plants were harvested at 149, 156, 163 and 170 days after sowing (DAS).
In this research; the pod yield per hectare, shelling percentage, 100-seed weight, maturity index, pod number per plant, pod weight per plant, protein and oil percentage characteristics and fatty acids composition of varieties were investigated. The results indicated that the pod yield per hectare, shelling percentage, 100-seed weight, maturity index, pod number per plant, pod weight per plant, oil percentage, stearic and oleic acids percentage values were increased when the harvesting delayed, but the protein content, palmitic and linoleic acids percentage were decreased.The pod yield was increased from 4185 kgha^{-1} to 5682 kgha^{-1} when the harvesting delayed from 149 DAS to 170 DAS in a two year average.

Key Words: Fatty acid, Harvesting time, Oil content, Peanut, Pod yield

INTRODUCTION

Peanut seeds contain 35-56% oil and 25-30% protein and 9.5-19.0% carbohydrate. In addition, they are a good source of mineral and vitamins. For this reason, it is an important source of edible oil and protein for human nutrition (Gulluoglu 2011; Arioglu et al., 2013; Chamberlin et al., 2014 and Chowdhury et al., 2015). Peanut (*Arachis hypogaea* L.) is an important oilseed crop for vegetable oil production. It contributes 8.7% of the total oil seeds production in the world. Peanut oil accounted for 3.0% of the world's vegetable oil production in 2015 (FAO, 2015).

Ishag (2000), Jordan et al. (2008) and Kaba et al. (2014) reported that peanut has indeterminate growth habit and the plants produced many flowers during the growing period,but only 15-20% of flowers produced mature pods.Young et al. (1982) reported that total pod production continually increased with growth period, but that harvested yield reached a peak and then declined due to increased field losses at delayed the harvesting date.

Court et al. (1984) and Gulluoglu et al. (2016a) found that delayed digging increased yield, sound mature kernels, shelling percentage and oil content. Sattayarak (1997) pointed out that harvesting dates exhibited certain effects on yield, 100-seed weight, shelling percentage, oil and protein contents in peanut. Canavar and Kaynak (2013) reported that, pod number and pod yield per plant, 100-seed weight, shelling percentage, pod yield, oil and protein content were increased by delaying the harvesting time.

Lu et al. (1997) reported that the lowest pod and seed yield, oil and protein content were found in the earliest harvested peanuts. Wright and Porter (1991) and Kaba et al. (2014) indicated that harvesting peanut too early reduced yield by 15% and economic value by 21%. Therefore, it is very important to harvest the peanut plant

at an appropriate time in order to get high yield and reduce yield losses.

Oil content is an important quality characteristic in peanut seed. The oil content of peanut seed influences by genotypic variation, growing conditions and maturity. The oil content of peanut varieties was increased by delaying the harvesting times (Lu et al., 1997 and Canavar and Kaynak, 2013). Young and Worthington (1974), Dwivedi et al. (1996) and Isleib et al. (2008) reported that fatty acid composition of peanut seed oil influenced by varietal and seasonal variation, genotypic variation, air and soil temperature, planting date, soil nutrient, growing conditions and maturity.

Andersen and Gorbet (2002) and Gulluoglu et al. (2016a) reported that, seed maturity can also influence the fatty acid composition of peanut. In general, oleic acid increases and linoleic acid decrease with seed maturity. The increase in oleic acid with seed maturity is normally accompanied by a decrease in palmitic and linoleic acids. Bovi (1982), Raheja et al. (1987) and Onemli (2012) reported that there was a negative correlation between oleic acid and linoleic acid.

Peanut has been grown as a main and double cropped after a small grain harvest in the Cukurova region in Turkey. Fatty acid composition of peanut is not constant. The fatty acid composition of peanut oil varies depending on varieties, growing conditions and maturity.The objective of the study is to investigate the effect of harvesting times on agronomic and quality traits of peanut varieties grown as a main crop in Mediterranean Region of Turkey.

MATERIALS AND METHODS

Materials

This experiment was conducted in 2015 and 2016 at Research Farm of Cukurova University (Southern Turkey, 36º59^{l} N, 35º18^{1} E and 23 m elevation) as a main crop. Halisbey, Sultan, Arioglu-2003, Osmaniye-2005, NC-7, Batem-5025, Flower-22, Flower-32, Flower-36, Brantley and Wilson peanut varieties belonging to Virginia market type were used as a plant material in this research.

The soil texture was clay loam. The soil tests indicated that pH of 7.5 with high concentrations of K_2O and low concentrations of P_2O_5. In addition, the organic matter and nitrogen content of the soil were very low. The lime content was 20.5% in the upper layers with increased levels in lower layers.

This study was conducted in Adana province in Turkey and in this region, winters are mild and rainy, whereas summers are dry and warm, which is a typical of a Mediterranean climate.The climate data during the 2015-2016 growing period and long term (LT) average (1982-2015) was shown in Table 1.

Table 1. The climate conditions during the 2015-2016 growing period and long term (LT) average (1982-2015) (Anonymous, 2017)

Months	Average temperature (ºC)			Precipitation (mm)			Relative humidity (%)		
	2015	2016	LT	2015	2016	LT	2015	2016	LT
April	16.9	20.5	17.3	21.5	36.6	48.6	61.2	59.2	67.6
May	22.5	21.6	21.4	65.7	87.9	41.2	64.8	69.3	67.3
June	25.0	27.1	25.2	4.8	45.6	14.5	69.6	66.1	67.9
July	28.4	29.5	27.8	0.4	0.2	7.9	69.8	67.5	71.4
August	30.0	29.9	28.4	10.9	8.2	6.1	63.4	69.0	70.8
September	28.4	26.3	25.1	13.1	39.8	15.7	64.8	61.8	63.2
October	23.4	23.1	20.6	32.1	0.0	45.7	63.7	56.4	59.5

Methods

The experiment was designed as a split plot design (harvesting times as main plots and varieties as subplots) with three replications. 250 kgha^{-1} of Di-ammonium phosphate (45 kgha^{-1} N, 115 kgha^{-1} P_2O_5) fertilizer was applied and incorporated to soil before planting. Ammonium nitrate (33%N) at the rates of 200 kgha^{-1} was applied two times; before first (beginning of flowering) and second (pod formation) irrigation in each years. Individual plots consisted of 4 rows 5.0 m long and 70 cm apart. The seeds were sown in line manually by hand on first week of April (5 April) and with 70x15 cm distance in a two year. During the growing period, recommended pesticides and fungicides were applied to control insects and diseases. The remaining cultural practices were applied during the growing period. The plants were harvested by hand at four different times with one week intervals (149 DAS, 156 DAS, 163 DAS and 170 DAS) at the beginning of September in 2015 and 2016.

Data collection and analysis: Data on agronomic and quality characteristics like pod number and pod weight per plant, maturity index, shelling percentage, 100-seed weight, pod yield per hectare,oil and protein content and fatty acids (palmitic, stearic, oleic and linoleic) content were recorded in a each harvesting time with seven days intervals (Gulluoglu et al., 2016b; AOCS, 2010 and William and Drexler, 1981).

The collected data on different parameters were statistically analyzed to obtain the level of significance using JUMP 8.1.0 package program with split plot design. The means differences were compared with the Least Significant Differences (LSD, 5%) Test.

RESULTS AND DISCUSSIONS

Pod number and pod weight

The average data belonging to pod number and pod weight per plant values of peanut varieties at different harvesting times has been presented in Table 2.

As it can be seen in Table 2, The differences between the harvesting times for the pod number per plant were statistically significant in 2015, 2016 and two years average.Pod number per plant values varied between 15.9 and 21.0 pods plant^{-1} in 2015, between 15.7 and 21.0 pods plant^{-1} in 2016.The pod number was increased when the harvesting delayed from 149 DAS to 170 DAS in both years. While the pod number per plant^{-1} was 15.8 pods plant^{-1} when the plants harvested at the 149 DAP, it was increased to 21.0 pods plant^{-1} plants harvested at the 170 DAP in a two-year average. Peanut has indeterminate growth habit and the plants produce flowers and pods as a long timeduring the growing period. For this reason,the pod number was increased when the harvesting delayed. Young et al. (1982) and Canavar and Kaynak (2013) reported that, pod number per plant was increased by delaying the harvesting time. Gulluoglu et al. (2016a) found that according to a two-year average the highest pod number per plant (38.83 pods plant^{-1}) was obtained when the plants were harvested at 180 DAP in Mediterranean region.

Table 2. Effects of harvesting times on pod number and pod weight values of peanut varieties

Treatments	Pod number (pods plant^{-1})			Pod weight (g plant^{-1})		
	2015	2016	2015-2016	2015	2016	2015-2016
Harvesting times (A)						
149 DAS	15.9	15.7	15.8	39.3	40.5	39.9
156 DAS	18.2	18.6	18.4	47.0	45.8	46.4
163 DAS	19.4	19.8	19.6	52.5	51.5	52.0
170 DAS	21.0	21.0	21.0	57.5	55.9	56.7
LSD(%5$_A$)	1.14	1.10	2.45	3.86	1.99	8.32
Varieties (B)						
Halisbey	21.9	21.1	22.0	61.4	63.0	62.2
Sultan	25.8	25.3	25.6	75.8	73.7	74.7
Arioglu-2003	22.1	21.7	21.9	49.0	47.7	48.4
Osmaniye-2005	26.4	27.0	26.7	70.2	72.7	71.4
NC-7	13.5	13.9	13.7	33.2	33.6	33.9
Batem-5025	15.0	15.2	15.1	40.9	38.0	39.5
Flower-22	17.7	17.7	17.7	44.3	42.5	43.4
Flower-32	18.8	18.7	18.7	49.9	48.1	49.0
Flower-36	17.1	17.1	17.1	46.5	45.9	46.2
Brantley	13.8	14.2	14.0	36.2	36.0	36.1
Wilson	13.0	13.4	13.2	31.7	31.4	31.6
LSD (%5$_B$)	1.89	1.39	1.10	6.42	2.53	3.35
LSD (%5$_{AxB}$)	NS	1.97	2.19	NS	3.58	6.70

The pod number per plant values of peanut varieties varied between 13.0-26.4 pods plant^{-1} in 2015 and 13.4-27.0 pods plant^{-1} in 2016.The differences between the varieties were found statistically significant for the pod number in both years.The reason of these differences between the varieties for the pod numbers originated from their genotypic background. Hassan et al. (2005) reported that significant differences for pod number per plant among peanut cultivars were attributed due to variation of the genotypes.The highest pod number per plant value was obtained from Osmaniye-2005 (26.4 and 27.0 pods plant^{-1}) and the lowest from Wilson (13.0 and 13.4 pods plant^{-1}) in 2015 and 2016. According to a two-year average, the pod number per plant was varied between 13.2 and 26.7 pods plant^{-1}. Gulluoglu et al. (2017) reported that the pod number per plant of the peanut varieties was varied between 22.44-52.40 pods plant^{-1} in main cropped conditions. Similar results were reported by some other researchers (Calıskan et al., 2008; Rahmianna et al., 2009; Canavar and Kaynak, 2013; Kaba et al., 2014 and Gulluoglu et al., 2016b). Interaction between the harvesting times and varieties for the pod number per plant was not statistically significant in 2015, but it was significant in 2016.

The differences between the harvesting times and peanut varieties were statistically significant for pod weight per plant in 2015, 2016 andin a two-year average. The pod weight per plant values varied between 39.3-57.5 g plant^{-1} in 2015, between 40.5-55.9g plant^{-1}in 2016 and between 39.9-56.7g plant^{-1}in a two-year average. By delaying the harvesting time from 149 DAS to 170 DAS, pod weight per plant was increased (Table 2). Gulluoglu et al. (2016a) reported that the pod weight was increased when the harvesting date was delayed from 148 DAP to 180 DAP. Pod formation and pod filling period was continually increased at the longer growing period. For this reason, the pod weight was increased when the harvesting date was delayed.

The pod weight per plant in peanut varieties varied between 31.7-75.8 g plant^{-1} in 2015, between 31.4-73.7 g plant^{-1} in 2016 and 31.6-74.7 g plant^{-1} in a two-year average. According to a two-year average,the highest pod weight was obtained from Sultan (74.7 g plant^{-1}) and the lowest from Wilson (31.6 g plant^{-1}). The differences for pod weight per plant among peanut cultivars were attributed due to variation of the genotypes. Gulluoglu et al. (2017) indicated that the pod weight per plant of peanut varieties were ranges from 40.5 g plant^{-1} to 95.55 g plant^{-1} in main cropped growing conditions.Interaction between the harvesting times and varieties for the pod weight per plant was not statistically significant in 2015, but significant in 2016 and in a two-year average. Rahmianna et al. (2009), Canavar and Kaynak (2013), Kaba et al. (2014) and Gulluoglu et al. (2016a) were found similar results.

100 Seed weight and maturity index

The differences between the harvesting times and peanut varieties were statistically significant for 100-seed weight. The 100-seed weight varied between 120.3-129.3 g in 2015, between 118.6-127.0 g in 2016 and 122.5-128.2 g in a two-year average (Table 3).

Table 3. Effects of harvesting times on 100-seed weight and maturity index values of peanut varieties

Treatments	100-seed weight (g)			Maturity index (%)		
	2015	2016	2015-2016	2015	2016	2015-2016
Harvesting times (A)						
149 DAS	120.3	118.6	119.5	59.0	57.6	58.3
156 DAS	123.7	121.3	122.5	60.8	59.7	60.2
163 DAS	127.0	124.7	125.9	63.0	62.9	63.0
170 DAS	129.3	127.0	128.2	65.6	65.0	65.3
LSD(%5_A)	2.84	2.39	5.74	0.95	1.28	1.41
Varieties (B)						
Halisbey	136.1	135.4	135.7	55.4	54.6	55.0
Sultan	135.3	131.8	133.6	56.7	55.5	56.1
Arioglu-2003	109.1	107.1	108.1	61.1	59.9	60.5
Osmaniye-2005	132.2	130.9	131.5	56.1	56.3	56.2
NC-7	121.8	119.7	120.8	67.5	66.5	67.0
Batem-5025	130.8	127.9	129.4	59.0	57.9	58.4
Flower-22	120.9	121.0	121.0	66.3	64.9	65.6
Flower-32	114.3	112.3	113.3	68.7	67.6	68.2
Flower-36	138.6	135.8	137.2	68.4	67.7	68.0
Brantley	125.2	121.0	123.1	65.0	64.5	64.8
Wilson	111.7	109.3	110.5	58.7	58.7	58.7
LSD (%5_B)	4.71	5.28	3.17	1.58	1.21	0.99
LSD (%5_{AxB})	NS	NS	NS	NS	NS	NS

According to-two year average, by delaying the harvesting time from 149 DAS to 170 DAS, 100-seed weight was increase from 119.5 g to 128.2 g. When the harvesting time was delayed, the pod filling period increased. For this reason, the 100-seed weight was increased when the harvesting time delayed. Talwar et al. (1999) indicated that the higher temperatures affect the reproductive growth adversely by increasing flower abortion and decreasing seed size. Knauft et al. (1986), Canavar and Kaynak (2013) and Gulluoglu et al. (2016a) reported that 100-seed weight was increased when the harvesting time was delayed.

The highest 100-seed weight was obtained from Flower-36 (138.6 g and 135.8 g) and the lowest from Arioglu-2003 (109.1 g and 107.1 g) in both years. The differences for 100-seed weight among peanut cultivars were attributed due to variation of the genotypes. Interaction between the harvesting times and varieties for the 100-seed weight was not statistically significant.

It can be seen in Table 3, the differences between the harvesting times and peanut varieties were significant for maturity index. The maturity index value varied between 59.0-65.6% in 2015, between 57.6-65.0% in 2016 and 58.3-65.3% in a two-year average. The maturity index was significantly increased when the harvesting time was delayed from 149 DAS to 170 DAS in both years. Peanut has indeterminate growth habit and the plants produce flowers and pods as a long timeduring the growing period. It can be seen in Table 3, the varieties showed an increasing trend in the maturity index as harvesting time delayed.

The maturity index of the peanut varieties varied between 55.4-68.7%, 54.6-67.7% and 55.0-68.2%, in 2015, 2016 and two years average, respectively.The maturity index of varieties was affected by the harvesting times. The maturity index value was increased when the harvesting delayed. The highest maturity index value was obtained from Flower-32 (68.2%) and the lowest from Halisbey (55.0%) varieties in a two-year average. Peanut varieties have different growing period. The maturity index value was lower in late varieties than early varieties in early harvesting. The differences between the varieties for the maturity index value originated from their

genotypic back ground and growing period (Arioglu et al., 2017a). Interaction between the harvesting times and varieties for the maturity index value was not statistically significant. Similar result was found by Young and Mason (1972), Kaba et al. (2014) and Gulluoglu et al. (2016a).

Shelling percentage and pod yield

The average data belonging to shelling percentage and pod yield data of peanut varieties at different harvesting times has been presented in Table 4.

The shelling percentage of peanut varieties was ranged from 69.1% to 71.5% in 2015 and from 67.8% to 70.8% in 2016 at different harvesting times (Table 4). The differences between the harvesting times and peanut varieties were statistically significant for shelling percentage in 2015, 2016 and two years average. When the harvesting time was delayed, the pod filling period extended and the pods fully matured. For this reason, the shelling percentage was increased when the harvesting time delayed. Shelling percentage was higher at each subsequent harvesting date. Overall the shelling percentage increased from 68.5% for the first harvesting date (149 DAS) to 68.5% for the last harvesting date (170 DAS) in a two-year average.

Table 4. Effects of harvesting times on shelling percentage and pod yield data of peanut varieties

Treatments	Shelling percentage (%)			Pod yield (kgha^{-1})		
	2015	2016	2015-2016	2015	2016	2015-2016
Harvesting times (A)						
149 DAS	69.1	67.8	68.5	4231	4138	4185
156 DAS	69.9	68.9	69.4	4764	4534	4649
163 DAS	70.8	69.9	70.4	5353	5010	5181
170 DAS	71.5	70.8	71.2	5873	5490	5682
LSD(%5$_A$)	1.05	0.55	1.85	360.5	22.1	971.2
Varieties (B)						
Halisbey	65.4	64.8	65.1	7818	7412	7615
Sultan	66.4	65.3	65.9	7553	7144	7348
Arioglu-2003	69.8	68.7	69.3	4745	4543	4644
Osmaniye-2005	68.0	67.5	67.8	7121	6916	7018
NC-7	73.6	72.3	73.0	3304	3212	3258
Batem-5025	73.0	71.9	72.4	4011	3749	3880
Flower-22	74.0	72.4	73.2	4463	4216	4340
Flower-32	72.6	71.8	72.2	5024	4819	4922
Flower-36	72.4	71.0	71.7	4831	4520	4676
Brantley	67.5	66.5	67.0	3595	3211	3403
Wilson	71.2	70.6	70.8	3140	2984	3062
LSD (%5$_B$)	1.74	1.04	0.96	597.8	257.0	314.4
LSD (%5$_{AxB}$)	NS	NS	NS	1195.7	363.5	628.8

The highest shelling percentage was obtained from Flower-22 (74.0% and 72.4%) and the lowest from Halisbey (65.4% and 64.8%) in both years. For a two-year average, the similar results were obtained. The differences between the varieties for the shelling percentage value originated from their genotypic background. Interaction between the harvesting times and varieties for the shelling percentage value was not significant. Similar results reported by Court et al. (1984), Knauft et al. (1986), Sattayarak (1997), Canavar and Kaynak (2013), Gulluoglu et al. (2016a), Gulluoglu et al. (2017) and Arioglu et al. (2017a).

The pod yield value varied between 4231-5873 kgha^{-1} in 2015, between 4138-5490 kgha^{-1} in 2016 and between 4185-5682 kgha^{-1} in a two-year average (Table 4). The differences between the harvesting times were statistically significant for pod yield per hectare in both years. The pod yield was increased when the harvesting time delayed. The highest pod yield was obtained from the peanut harvested at 170 DAS. According to a two-year average, the pod yield was increased 35.8% when the harvesting time delayed from 149 DAS to 170 DAS.

Pod number and pod weight per plant, shelling percentage and 100-seed weight are the very important agronomic characteristics for the pod yield. As it can be seen in Table 2,3 and 4 the data belonging to these characteristics were found higher in late harvesting than early harvesting. Park and Oh (1992) found that the pod yield was positively correlated to pod number, matured seed percent and 100-seed weight. Rahmianna et al. (2009) found out that harvesting times significantly affected weight of pods, well filled seeds, and shriveled seeds. A 10-day harvest delay resulted in 14.3% yield increases. Court et al. (1984) indicated that the pod yield increased (48.2%) when the harvest delayed from 2 September to 12 October. Wright and Porter (1991) and Kaba et al. (2014) further indicated that harvesting peanut too early can reduced yield by 15% and economic value by 21%. Gulluoglu et al. (2016a) reported that, the pod yield was increased 31.0% when the harvesting time delayed from 148 DAP to 180 DAP. Similar results were

supported by findings of Knauft et al. (1986), Sattayarak (1997), Lu et al. (1997), Parasad et al. (2000), Rahmianna et al. (2009) and Canavar and Kaynak (2013).

The difference between the peanut varieties was statistically significant for the pod yield per hectare. Pod yield of the varieties ranged from 3140 to 7818 kgha^{-1} in 2015 and from 2984 to 7412 kgha^{-1} in 2016 in different peanut varieties.The highest pod yield was obtained from Halisbey (7818 kgha^{-1}and 7412 kgha^{-1}) and the lowest from Wilson (3140 kgha^{-1} and 2984 kgha^{-1}) varieties in both years (Table 4). Gulluoglu et al. (2017) indicated that the pod yield per hectare of peanut varieties were ranges from 3666 to 8796 kgha^{-1} in main cropped growing conditions. Duncan et al. (1978) suggested that the length of the pod filling period and the rate of pod establishment is the best explain the variation in peanut yield.The differences between the varieties for the pod yield originated from their genotypic background. Interaction between the harvesting times and varieties for the pod yield were significant in both years.

Protein and oil content

It can be seen in Table 5, the differences between the harvesting times and peanut varieties were statistically significant for oil percentage in 2015, 2016 and in a two-year average. The oil percentage values varied between 47.8-50.3%, 47.0-49.3% and 47.4-49.8% in 2015, 2016 and two years average, respectively at different harvesting times. The oil percentage was increased when the harvesting time delayed.

Table 5. Effects of harvesting times on protein and oil content values of peanut varieties

Treatments	Protein content (%)			Oil content (%)		
	2015	2016	2015-2016	2015	2016	2015-2016
Harvesting times (A)						
149 DAS	25.52	25.84	25.68	47.8	47.0	47.4
156 DAS	24.86	25.17	25.02	48.6	47.7	48.2
163 DAS	23.71	24.01	23.86	49.4	48.5	48.9
170 DAS	22.88	23.17	23.02	50.3	49.3	49.8
LSD(%5$_A$)	0.125	0.188	0.239	0.70	0.25	0.32
Varieties (B)						
Halisbey	24.42	24.73	24.58	49.4	48.7	49.0
Sultan	24.34	24.64	24.49	49.2	48.4	48.8
Arioglu-2003	25.07	25.39	25.23	50.7	49.8	50.3
Osmaniye-2005	25.24	25.56	25.40	51.0	49.9	50.5
NC-7	23.37	23.66	23.52	47.3	46.4	46.9
Batem-5025	24.93	25.24	25.09	50.4	49.2	49.8
Flower-22	23.07	23.36	23.21	46.6	46.0	46.3
Flower-32	22.99	23.27	23.13	46.5	45.6	46.0
Flower-36	24.36	24.67	24.52	49.2	48.4	48.8
Brantley	23.64	23.93	23.79	47.8	47.0	47.4
Wilson	25.26	25.57	25.41	51.1	50.0	50.5
LSD (%5$_B$)	0.208	0.200	0.103	1.17	0.44	0.23
LSD (%5$_{AxB}$)	NS	NS	NS	2.34	NS	NS

Oil content is an important quality characteristic in peanut seed. The oil content of peanut seed influences by genotypic variation, growing conditions and maturity. Court et al. (1984) reported that the oil content was 45.8% in 2 September it was increased to 47.8% in 12 October. Sattayarak (1997), Lu et al. (1997) and Canavar and Kaynak (2013) reported that oil content was increased by delaying the harvesting times.

The oil percentage values of the peanut varieties varied between 46.5-51.1% in 2015, between 45.6-50.0% in 2016 and 46.0-50.5% in a two-year average. The highest oil percentage was obtained from Wilson (51.1% and 50.0%) and the lowest from Flower-32 (46.5% and 45.6%) in both years (Table 5). Hassan et al. (2005), Yav et al. (2008), Isleib et al. (2008) and Gulluoglu et al. (2017) reported that the oil percentage of peanut kernel varies between 35 and 56% depending on genotype and growing conditions, and the oil content of peanut varieties influence by genotype, seed maturity, climatic conditions, geographical location, growing season and growing conditions.Interaction between the harvesting times and varieties for the oil percentage was significant. Similar results were reported by some other researchers (Court et al., 1984; Sattayarak, 1997; Lu et al., 1997; Canavar and Kaynak, 2013; Arioglu et al., 2017a and Arioglu et al., 2017b)

The protein percentage values varied between 22.88-25.52% in 2015, between 23.17-25.84% in 2016 and 23.02-25.68% in a two-year average at different harvesting times (Table 5).The differences between the harvesting times and peanut varieties were statistically significant for protein percentage in both years and in a two-year average. The protein percentage was decreased when the harvesting time delayed. According to a two-year average, the protein percentage was decreased from 25.68% to 23.02% when the harvesting time was delayed

from 149 DAS to 170 DAS (Table 5). Sarkees (2015) reported that protein percentage was decreased from 22.0% to 19.8% when the planting delayed from April 22 to June 3. Gulluoglu et al. (2016a) found that the protein percentage was decreased from 25.60 to 24.65% when the harvesting time delayed from 148 DAP to 188 DAP.

It can be seen in Table 5, the protein percentage of peanut varieties values varied between 22.99-25.26%, 23.27-25.57% and 23.13-25.41% in 2015, 2016 and two years average, respectively. The highest protein percentage was obtained from Wilson (25.26%, 25.57% and 25.41%) and the lowest from Flower-32 (22.99%, 23.275% and 23.13%) in both years and two years average at different harvesting times.

The protein content of peanut varieties is influence by genotype, seed maturity, climatic conditions, geographical location and growing season. Gulluoglu et al. (2017) reported that the protein percentage of peanut varieties varied between 24.38% and 28.29% in main crop growing season. Interaction between the harvesting times and varieties for the protein percentage was not significant in both years and two years average. These results are in agreement with the findings of Court et al. (1984), Sarkees (2015) and Arioglu et al. (2017a).

Fatty acids composition

The average data belonging to saturated (palmitic and stearic acids) and unsaturated (oleic and linoleic acids) values of peanut varieties at different harvesting times has been presented in Table 6 and 7.

Table 6. Effects of harvesting times on palmitic and stearic acids content of peanut varieties

Treatments	Palmitic acid			Stearic acid		
	2015	2016	2015-2016	2015	2016	2015-2016
Harvesting times (A)						
149 DAS	10.16	10.22	10.19	3.23	3.29	3.26
156 DAS	9.81	9.93	9.87	3.34	3.40	3.37
163 DAS	9.46	9.69	9.58	3.50	3.54	3.52
170 DAS	9.15	9.45	9.30	3.73	3.70	3.72
LSD(%5_A)	0.651	0.081	1.008	0.039	0.062	0.145
Varieties (B)						
Halisbey	9.76	9.97	9.87	3.28	3.31	3.30
Sultan	10.01	10.10	10.06	3.47	3.40	3.44
Arioglu-2003	10.14	10.25	10.20	3.12	3.17	3.15
Osmaniye-2005	10.30	10.48	10.39	2.80	2.84	2.82
NC-7	8.77	8.51	8.64	3.32	3.39	3.36
Batem-5025	8.42	8.53	8.48	3.50	3.55	3.53
Flower-22	12.16	12.06	12.11	3.89	3.93	3.91
Flower-32	11.57	12.08	11.83	4.04	4.09	4.07
Flower-36	11.52	11.91	11.72	4.14	4.19	4.17
Brantley	5.55	5.80	5.68	3.28	3.33	3.31
Wilson	7.92	8.40	8.16	3.11	3.13	3.12
LSD (%5_B)	0.220	0.134	0.128	0.059	0.102	0.059
LSD (%5_{AxB})	0.441	0.267	0.256	0.119	NS	0.117

The major fatty acids components are oleic acid, linoleic acid, palmitic acid and stearic acid in peanut oil. Andersen and Gorbet (2002) and Chowdhury et al. (2015) reported that the amount of saturated and unsaturated fatty acids in peanut oil varies from 10.92% to 17.47% and from 81.13% to 94.81%, respectively. How and Young (1983), Carrin and Carelli (2010), Gulluoglu et al. (2016a) and Gulluoglu et al. (2016b) indicated that the fatty acid composition of peanut seed oil varies depending on the genotype, seed maturity, climate conditions, growth location, and interaction between these factors.

Saturated Fatty acids (Palmitic and stearic acids) content

As it can be seen inTable 6, the differences between the harvesting times and peanut varieties were statistically significant for the palmitic acid and stearic acid percentage in 2015, 2016 and in a two-year average.

The palmitic acid percentages varied between 9.15-10.16% in 2015, 9.45-10.22% in 2016 and 9.30-10.19% in a two-year average at different harvesting times. The palmitic acid percentage was decreased when the harvesting time was delayed. Gulluoglu et al. (2016a) found out that palmitic acid content was decreased when the harvesting time delayed. Court et al. (1984), Knauft et al. (1986), Raheja et al. (1987), Hassan et al. (2005), Escobedo et al. (2015), Chowdhury et al. (2015) and Golukcu et al. (2016) were found similar results.

The palmitic acid percentage of peanut varieties varied between 5.68-12.11% in a two-year average. According to a two-year average, the highest palmatic acid percentage (12.11%) was found in Flower-22 cultivar compared with rest of the cultivars. The lowest percentage of palmitic acid (5.68%) was found in Brantley varieties (Table 6).The saturated fatty acids content in peanut oil were

strongly influenced by genotype (Isleib et al., 2008). Gulluoglu et al. (2016b) indicated that the palmitic acid percentage of peanut varieties varied between 8.49-12.80% in main crop growing conditions. Significant differences for palmitic acid among cultivars are attributable to the genetic makeup and place of their origin (Hassan et al., 2005). The interaction between the harvesting time and varieties was significant in both years and two years average.

The stearic acid percentages varied between 3.23-3.73%, 3.29-3.70% and 3.26-3.72% in 2015, 2016 and in a two-year average, respectively (Table 6) at different harvesting times. The stearic acid percentage was increased when the harvesting time delayed.Young et al. (1972), Knauft et al. (1986) and Gulluoglu et al. (2016a) pointed outthat digging delays tended to give peanut oil with higher stearic acid content and the stearic acid content was increased when the harvesting time delayed.

The highest stearic acid percentage was obtained from Flower-36 (4.14%, 4.19% and 4.17%) and the lowest from Osmaniye-2005 (2.80%, 2.84% and 2.82%) varieties in both years and two years average at different harvesting times (Table 6). Gulluoglu et al. (2016b) indicated that the stearic acid percentage of peanut varieties varied between 8.49-12.80% in main crop growing conditions in Mediterranean region. The interaction between the harvesting time and varieties was significant in 2015 and two years average, but was not significant in 2016. These results are in agreement with the findings of Young et al. (1972), Brown et al. (1975), Knauft et al. (1986), Raheja et al. (1987), Chowdhury et al. (2015) and Golukcu et al. (2016).

Unsaturated fatty acids (Oleic and linoleic acids) content

Peanut oil is rich in oleic and linoleic acids. Oleic acid content in peanut genotypes can vary from 21% to 85% and linoleic acid from 2% to 43%. In this research, the oleic acid percentage varied from 52.83% to 56.05% in 2015, from 54.54-58.71% in 2016 and 53.69-57.38% in a two-year average (Table 7).The differences between the harvesting times were significant for the oleic acids percentage in both years and in a two-year average. According to a two-year average, while the oleic acid percentage was 53.69% at the harvesting 149 DAS, it increased up to 57.38% at the harvesting 170 DAS. As the harvesting time was delayed, the oleic acid percentage increased. Andersen and Gorbet (2002) and Gulluoglu et al. (2016a) reported that, seed maturity can also influence the fatty acid composition of peanut. Young et al. (1972) and Knauft et al. (1986) pointed out that digging delays tended to give peanut oil with higher oleic acid and less linoleic acid. Gulluoglu et al. (2016a) indicated that the oleic acid percentage was increased when the harvesting times delayed. Bovi (1982), Raheja et al. (1987) and Onemli (2012) reported that there was a negative correlation between oleic acid and linoleic acid content.

Table 7. Effects of harvesting times on oleic and linoleic acids content of peanut varieties

Treatments	Oleic acid (%)			Linoleic acid (%)		
	2015	2016	2015-2016	2015	2016	2015-2016
Harvesting times (A)						
149 DAS	52.83	54.54	53.69	24.44	23.01	23.73
156 DAS	53.97	56.01	54.99	23.42	21.79	22.61
163 DAS	55.08	57.38	56.23	22.65	21.22	21.94
170 DAS	56.05	58.71	57.38	21.94	19.53	20.74
LSD (%5_A)	0.399	0.715	1.143	0.215	0.097	0.394
Varieties (B)						
Halisbey	53.69	54.39	54.04	23.66	23.19	23.43
Sultan	53.71	53.77	53.74	24.62	24.38	24.50
Arioglu-2003	52.41	53.85	53.13	25.09	24.64	24.87
Osmaniye-2005	51.53	52.11	51.82	26.69	26.14	26..42
NC-7	59.77	63.01	61.39	17.79	17.28	17.54
Batem-5025	59.79	62.99	61.39	17.29	16.75	17.02
Flower-22	46.12	47.56	46.84	29.48	26.67	28.08
Flower-32	43.55	44.13	43.84	32.06	32.04	32.05
Flower-36	46.10	47.00	46.55	30.00	29.63	29.82
Brantley	79.21	80.91	80.06	2.19	2.17	2.18
Wilson	53.43	63.56	58.50	25.39	12.38	18.89
LSD (%5_B)	0.341	1.185	0.612	0.381	0.160	0.205
LSD (%5_{AxB})	0.682	2.371	1.224	0.762	0.321	0.410

The oleic acid percentage of peanut varieties varied between 43.55-79.21% in 2015, between 44.13-80.91% in 2016 and 43.84-80.06% in a two-year average. The differences between the varieties for the oleic acid percentage were significant in both years and two years average. As it can be seen in Table 7, the highest oleic acid percentage was obtained from Brantley (79.21%, 80.91% and 80.06%) and the lowest from Flower-32 (43.55%, 44.13% and 43.84%) varieties in both years and two years average. The fatty acids composition of Virginia

type peanut cultivars varies 56.4-60.3% oleic and 24.2-26.8% linoleic acids (Brown et al., 1975). Gulluoglu et al. (2016b) indicated that the oleic acid percentage of peanut varieties varied between 39.80-81.13% in main crop growing conditions in Mediterranean region. The interaction between the harvesting time and varieties for the oleic acid content was significant in 2015, 2016 and in a two-year average. The results are corresponded well with the findings of Knauft et al. (1986), Dwivedi et al. (1996), Andersen and Gorbet (2002), Yav et al. (2008), Onemli (2012), Chaiyadee et al. (2013), Mzimbiri et al. (2014), Chowdhury et al. (2015), Golukcu et al. (2016) and Gulluoglu et al. (2016a).

The linoleic acid percentage varied from 21.94 % to 24.44% in 2015 and from 19.53% to 23.01% in 2016 at different harvesting times. However, the linoleic acid percentage was decreased from 23.73% to 20.74% when the harvesting time was delayed from 149 DAP to 170 DAP in a two-year average (Table 7). The differences between the varieties for the linoleic acid percentage were significant in both years and two years average. As the harvesting time was delayed, the linoleic acid percentage decreased substantially. In general, oleic acid increases and linoleic acid decreases with seed maturity. Bovi (1982) Raheja et al. (1987) and Onemli (2012) reported that there was a negative correlation between oleic acid and linoleic acid. Gulluoglu et al. (2016a) found out that the linoleic acid percentage was decreased from 26.78 to 24.65% when the harvesting times delayed from 148 to 188 DAP.

The differences between the peanut varieties for the linoleic acid were significant in 2915, 2016 and in a two-year average. The linoleic acid percentage of peanut varieties varied between 2.19-32.06% in 2015, between 2.17-32.04% in 2016 and between 2.18-32.05% in a two-year average (Table 7). According to a two-year average, the highest linoleic acid percentage was obtained from Flower-32 (32.05%) and the lowest from Brantley (2.18%) varieties at different harvesting times. Andersen and Gorbet (2002) reported that linoleic acid content in peanut genotypes varied 2 to 43% and they reported that seed maturity can also influence the fatty acid composition of peanut. Bovi (1982), Raheja et al. (1987) and Onemli (2012) reported that there was a negative correlation between oleic acid and linoleic acid. Gulluoglu et al. (2016b) indicated that the linoleic acid percentage of peanut varieties varied between 1.73-36.38% in main crop growing conditions in Mediterranean region. The interaction between the harvesting time and varieties for the linoleic acid content was significant in 2015, 2016 and in a two-year average. Young et al. (1972), Knauft et al. (1986), Raheja et al. (1987), Hinds, (1995), Isleib et al. (2008), Onemli (2012), Chowdhury et al. (2015) and Golukcu et al. (2016) was found similar results.

CONCLUSION

Some agronomic and quality characteristics of peanut are influenced by genotype and environmental conditions during the growing season. Peanut has indeterminate growth habit and the plants produced many flowers during the growing period, but only 15-20% of flowers produced mature pods. Pod production continually increased with growth period, but harvested yield reached a peak and then declined due to increased field losses at delayed the harvesting date. Pod number and pod weight per plant, shelling percentage, maturity index, 100-seed weight and pod yield per hectare were increased when the harvesting times delayed. For this reason, it is very important cultural practice to determine the optimum harvesting time in peanut production.

Oil content and fatty acid composition are important quality characteristics in peanut seed and these factors influence by genotype, growing conditions and maturity. The major fatty acids components are oleic acid, linoleic acid, palmitic acid and stearic acid in peanut oil. The amount of saturated and unsaturated fatty acids in peanut oil varies from 10.92% to 17.47% and from 81.13% to 94.81%, respectively. In this study, the oil content, stearic acid and oleic acid percentage were increased by delaying the harvesting times, but protein content, palmitic acid and linoleic acid percentage were decreased.The oil and fatty acids content of peanut varieties were found differ at the harvesting times.

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