# THE DETERMINATION OF SOME AGRONOMIC AND OIL QUALITY CHARACTERISTICS OF PEANUT BREEDING LINES

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**Abstract**

This study was conducted as a main crop in University of Cukurova, Faculty of Agriculture Field Crops Department in 2016. The objective of this research was to determine some agronomic and quality characteristics of peanut breeding lines. In this study, 22 peanut lines (F6) belonging to Brantley (High oleic) x Halisbey (High yield) crossing were used as a plant material. The experimental design was a Randomized Complete Block with three replications. Pod number and pod weight per plant, 100-seed weight, shelling percentage, oil and protein content, saturated (Palmitic, stearic, arachidic and lignoceric acid) and unsaturated (Oleic, linoleic and linolenic acid) fatty acids percentage and pod yield per hectare values of lines were investigated. As a result, the pod number per plant of breeding lines was between 24.9-34.9 pod plant$^{-1}$, pod weight was 73.3-91.2 g plant$^{-1}$, 100-seed weight 118.0-148.6 g, shelling percentage was 59.5-66.9% and pod yield was 6064-9232 kg ha$^{-1}$. The oil content and oleic acid percentage of breeding lines were varied between 41.20-55.95% and 51.97-80.00%, respectively.

**Keywords:** Peanut, breeding lines, agronomic characteristic, oleic acid and pod yield.

## Introduction

Peanuts are grown worldwide in the tropics and temperate zones primarily as an oilseed crop. The world annual peanut production is around 45 million tons (Carrin and Carelli, 2010 and FAO, 2015). About two-thirds of total peanut production is crushed for oil and the remaining one-third is used in confectionery products in the world (Dwivedi et al. 1996). For this reason, peanut (*Arachis hypogaea* L.) is an important oilseed crop for vegetable oil production in the world (peanut oil accounted for 3.0% of the world's vegetable oil production) (FAO, 2015). Peanut seeds contain 44-56% oil and 22-30% protein and 15.0-18.0% carbohydrate. In addition, they are a good source of mineral (P, Ca, Mg and K) and vitamins (E, K and B group). For this reason, it is an important source of edible oil and protein for human nutrition in the world. Peanuts are also a cheap source of protein, a good source of essential vitamins and minerals, and a component of many food products (Savage and Keenan 1994 and Gulluoglu et al. 2016a). Yield of peanut is a complex phenomenon, a function of genetic factor as influenced by climate and managements. Variety selection is one of the main factors that play an important role on yield and quality of peanut. Cox (1979), Ketring (1984) and Caliskan et al. (2008), indicated that management practices such as variety selection, time of sowing and growing period of varieties may influence the growth, yield and seed quality of peanut. Arioglu et al. (2016) found that the pod yield was varied between 3830-8790 kg ha$^{-1}$ and the highest pod yield was obtained from Sultan (8790 kg ha$^{-1}$) and Halisbey (7792 kg ha$^{-1}$) varieties. The oil and protein content of varieties were varied between 47-51% and 24-28%, respectively.The fatty acid composition of peanut is becoming increasingly important diet for health living. The nutritional qualities of peanut depend on the relative proportion of saturated and unsaturated fatty acids in the oil. A high proportion of polyunsaturated fatty acid is desirable because it lowers plasma cholesterol and low-density lipoprotein (LDL) content, which may reduce the risk of coronary heart disease (Dwivedi et al. 1996 and Mzimbiri et al. 2014). The oil content of Virginia type peanut cultivars varied between 45.0-58.6% (Carrin and Carelli, 2010). The fatty acid composition of peanut oil varies depending on

the genotype, seed maturity, climate conditions, growth location, and interaction between these factors (Young, 1996). The major fatty acids present as acylglycerols in peanut oil are palmitic (C16:0), oleic (C18:1), and linoleic (C18:2) acids. Normally, stearic (C18:0), arachidic (C20:0), eicosenoic (C20:1), behenic (C22:0), and lignoceric (C24:0) acid occur in minor proportions, while a trace of linolenic fatty acid (C18:3) can take place (Carrin and Carelli, 2010). The fatty acids composition of Virginia type peanut varieties varies between 9.0-9.1% palmitic, 2.2-2.4% stearic, 56.4-60.3% oleic, 24.2-26.8% linoleic, 1.1-1.8% arachidic1.0-1.1% eicosenoic and 1.8-2.4% behenic acids (Brown et al. 1975). The annual peanut production is around 148.000 tons from the 38.000 ha harvested area in Turkey and the average pod yield is 3.9 ton $ha^{-1}$. Peanut can be grown at different seasons such as main and double crop for the suitable climate in Mediterranean region in Turkey. Main crop peanut production in the Mediterranean region accounts for 60% of the country's total production (TUIK, 2015). NC-7 peanut variety was commonly grown in the Mediterranean region. This variety has lower yield and susceptible to iron chlorosis. Other side, it has lower oleic acid content. It is necessary to store as a long period of peanut seed, the oleic acid content has to high. For these reasons, the farmers need to high yielding, tolerant to iron chlorosis and high oleic acid content peanut varieties. The agronomic and quality characteristic of peanut varies depending on growing conditions and varieties. The objective of the study was to determine some agronomic and quality characteristics of peanut breeding lines (Brantley x Halisbey) grown as a main crop in Turkey.

**Material and methods**

This experiment was conducted in 2016 at Research Farm of Cukurova University (Southern Turkey, $36^{o}59^{l}$ N, $35^{o}18^{1}$ E; 23 elevation) as a main crop. Halisbey and Brantley varieties (st) and 22 advanced (F6) breeding lines (Brantley x Halisbey) 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. Mediterranean climate prevails in this region. Winters are warm and rainy, whereas summers are dry and hot. The average monthly air temperature and precipitation during the research period (April-September) was varied between 16.9-30.0$^{o}$C and 0.4 mm and 130.0 mm, respectively. The average relative humidity was between 61.2% and 70.0%. The differences between the year and long term for the climatic data were not significant (Anonymous, 2016). The experiment was designed at Randomized Complete Block with three times. The experimental site was cultivated deeply by the moldboard following the harvest of the previous crop in the autumn and then the soil was prepared by using disked-harrowed the day of planting. 250 kg $ha^{-1}$ of Di-ammonium phosphate (45 kg $ha^{-1}$ N, 115 kg $ha^{-1}$ $P_2O_5$) fertilizer was applied and incorporated to soil before planting. Ammonium nitrate (33%N) at the rates of 200 kg $ha^{-1}$ was applied two times; before first (beginning of flowering) and second (pod formation) irrigation. Plots consisted of 4 rows 5.0 m long and 70 cm apart. The seeds were sown in line manually by hand on 11 April 2016 and with 70 x 15 cm distance. During the growing period, recommended pesticides and fungicides were applied to control insects and diseases. During the growing period, other standard cultural practices were done. The plants were harvested by hand at the 20$^{th}$ of September 2016.

*Data collection and analysis*

Per plant data were measured from the 20 plants that were randomly selected from the central rows of each plot and then harvested by hand. Average pod number (pods $plant^{-1}$) and pod weight (g $plant^{-1}$) were calculated as the quotient of their respective values and the number of sampled plants. Pod yield was determined on the center two rows of each plot. Samples were dried to uniform 10% moisture, cleaned, and weighted. Pod yield per hectare, shelling percentage (%), 100-seed weight (g), protein and oil content (%) data were obtained after harvest (Gulluoglu, 2011). Determination of oil and protein percentage was analyzed and estimated according to Association of Official Analytical

chemists (AOCS, 2010). Fatty acid content was measured as *fatty acid methyl esters* using Gas Chromatograph (GC) according to AOCS (2010).
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 discussion**
The data belonging to pod number and pod weight per plant, shelling percentage, 100-seed weight, pod yield per hectare, oil content, protein content and fatty acids composition of peanut breeding lines has been presented in Table 1 and 2.

Table 1. The data belonging to pod number and pod weight per plant, shelling percentage, 100-seed weight, oil content, protein content and pod yield per hectare of peanut breeding lines

| Breeding lines | Pod number (pods plant$^{-1}$) | Pod weight (g plant$^{-1}$) | Shelling percentage (%) | 100-seed weight (g) | Protein content (%) | Oil content (%) | Pod yield (kg ha$^{-1}$) |
|---|---|---|---|---|---|---|---|
| Halisbey | 31.0 | 80.8 | 60.8 | 131.6 | 24.53 | 45.27 | 8197 |
| Brantley | 27.8 | 62.5 | 67.0 | 124.9 | 24.46 | 46.10 | 6287 |
| YF-1 | 31.1 | 73.3 | 61.9 | 124.8 | 27.05 | 45.25 | 7147 |
| YF-2 | 30.0 | 77.8 | 62.8 | 130.8 | 25.02 | 45.89 | 8643 |
| YF-3 | 27.4 | 80.3 | 65.5 | 147.2 | 26.13 | 42.50 | 8531 |
| YF-4 | 31.6 | 79.8 | 60.6 | 118.4 | 25.69 | 45.45 | 8627 |
| YF-5 | 28.5 | 81.5 | 65.6 | 141.7 | 26.45 | 45.00 | 9025 |
| YF-6 | 31.3 | 91.2 | 60.3 | 130.5 | 26.42 | 45.46 | 8165 |
| YF-7 | 31.0 | 81.8 | 61.2 | 146.8 | 27.19 | 48.46 | 8277 |
| YF-8 | 31.6 | 82.0 | 66.9 | 122.0 | 25.64 | 43.38 | 7943 |
| YF-9 | 30.9 | 85.3 | 64.1 | 130.7 | 25.87 | 43.15 | 8420 |
| YF-10 | 27.7 | 83.5 | 59.1 | 148.0 | 26.08 | 44.84 | 7608 |
| YF-11 | 30.3 | 85.2 | 61.0 | 143.0 | 25.13 | 43.88 | 8404 |
| YF-12 | 31.0 | 83.3 | 62.3 | 139.9 | 25.41 | 45.81 | 9073 |
| YF-13 | 30.8 | 82.3 | 60.2 | 128.9 | 25.48 | 46.72 | 7592 |
| YF-14 | 29.4 | 82.7 | 64.2 | 134.8 | 25.65 | 49.62 | 8770 |
| YF-15 | 33.4 | 81.7 | 60.9 | 148.6 | 25.76 | 46.18 | 9232 |
| YF-16 | 24.9 | 73.5 | 63.4 | 140.6 | 25.96 | 44.68 | 6064 |
| YF-17 | 26.9 | 74.5 | 63.4 | 134.5 | 24.96 | 41.20 | 8213 |
| YF-18 | 30.5 | 83.7 | 56.1 | 132.6 | 25.63 | 43.13 | 8674 |
| YF-19 | 34.9 | 87.2 | 61.6 | 118.0 | 27.13 | 55.95 | 8834 |
| YF-20 | 30.2 | 80.8 | 61.4 | 136.9 | 26.25 | 42.11 | 7767 |
| YF-21 | 29.6 | 77.7 | 63.1 | 133.5 | 26.06 | 44.94 | 7242 |
| YF-22 | 31.7 | 85.5 | 63.3 | 133.3 | 25.27 | 45.08 | 8643 |
| Average | 30.1 | 80.7 | 62.4 | 134.2 | 25.86 | 45.42 | 8141 |
| CV(%) | 8.74 | 7.94 | 3.35 | 2.67 | 1.40 | 3.40 | 12.53 |
| LSD (5%) | 4.26 | 10.28 | 3.44 | 5.89 | 0.60 | 2.54 | 1675.8 |

*Pod number per plant*
It can be seen in Table 1, the differences between the breeding lines were statistically significant for the pod number per plant. The pod number of breeding lines varied between 24.9-34.9 pods plant$^{-1}$. The average pod number of breeding lines was 30.1 pods plant$^{-1}$. The highest pod number per plant was obtained from YF-19 (34.9 pods plant$^{-1}$) and the lowest from YF-16 (24.9 pods plant$^{-1}$). The genotypic background was effective on pod number of peanut. Pod number per plant in Virginia market type peanut varieties was varied between 16.24-40.47 pods plant$^{-1}$ depending on variety and

management (Gulluoglu, 2011, Arioglu et al. 2013; Gulluoglu et al. 2016b; Arioglu et al. 2016 and Kurt et al. 2017).

*Pod weight per plant*

The pod weight per plant of breeding lines varied between 62.5 - 91.2 g plant$^{-1}$. The differences between the breeding lines were statistically significant for the pod weight per plant. The average pod weight was 80.7 g plant$^{-1}$. The pod weight was 62.5 and 91.2 g plant$^{-1}$ in parent of line it was increased to 91.2 g plant$^{-1}$ in some breeding lines (YF-6). The pod weight of the lines except YF-6 was found higher than Brantley variety (Table 1). Pod weight per plant is an important yield component in peanut production. Pod weight was the higher in YF-15, YF-5, YF-19 and YF-12 breeding lines than the others lines. Virginia market type peanut varieties had larger pods and seeds compared to other market types. The yield and some agronomic characteristics of peanut are influenced by genotype and environmental conditions. Pod weight per plant in Virginia market type peanut varieties was varied between 37.28-93.67 g plant$^{-1}$ depending on variety and management (Gulluoglu, 2011; Arioglu et al. 2013; Gulluoglu et al. 2016b; Arioglu et al. 2016 and Kurt et al. 2017).

*Shelling percentage*

The differences between the breeding lines were statistically significant for the shelling percentage. The shelling percentage of breeding lines varied between 56.1-66.9%. The shelling percentage was the highest in YF-8 (66.9%) and the lowest in YF-18 (56.1%) breeding lines. The average shelling percentage of breeding lines was found 62.4% (Table 1). The shelling percentage was higher in YF-3 (65.5%), YF-5 (65.6%), YF-9 (64.1%) and YF-14 (64.2%) than the others breeding lines. The shelling percentage is an important characteristic for the pod quality in peanut. It varies between 63.63-68.83% depending to variety and management in peanut. Some agronomic characteristics of peanut are influenced by several groups of factors including environmental factors, genetic factors and interaction of these factors (Isleib et al. 2008). These results are in agreement with the findings of Gulluoglu (2011), Arioglu et al. (2013), Gulluoglu et al. (2016b), Arioglu et al. (2016) and Kurt et al. (2017).

*100-seed weight*

The differences between the lines for the 100-seeds weight were statistically significant. The 100-seeds weight of the breeding lines varied between 118.0-148.6 g and the average 100-seed weight was 134.2 g. While the 100-seed weight of the parent was 124.9 g and 131.6 g, it was increased to 148.6 g in YF-15 and 148.0 g in YF-10 (Table 1). Virginia market type peanut varieties had larger pods and seeds compared to other market types. The yield and some agronomic characteristics such as pod number, pod weight, 100-seed weight and shelling percentage of peanut are influenced by genotype and environmental conditions. The 100-seed weight of the peanut varieties varies from 112.52 to 138.05 g (Gulluoglu, 2011; Arioglu et al. 2013; Gulluoglu et al. 2016b; Arioglu et al. 2016 and Kurt et al. 2017).

*Protein and oil content*

It can be seen in Table 1, the protein and oil content of the breeding lines varied between 24.46-27.18% and 41.20-55.95%, respectively. The differences between the lines for the protein and oil content were statistically significant. The oil content was the highest in YF-19 (55.95%) and the lowest in YF-17 (41.20%) lines. The average oil content was 45.42% in breeding lines. Brown et al. (1975) and Holaday and Pearson (1974) reported that genotypic differences for oil content were highly influenced by location, seasons, and growing conditions in peanut. Oil content of peanut has been studied in different cultivars and different environments and it has been reported that the oil content of Virginia type peanut cultivars varied between 45.0-58.6% (Carrin and Carelli, 2010). The highest protein percentage was obtained from YF-4 (27.18%) and the lowest from YF-20 (24.46%).

The average protein content was 25.87% in breeding lines (Table 1). Protein content of peanut varieties genetically controlled. The protein content of the peanut varieties varies between 24.15-28.50% (Arioglu et al. 2013; Gulluoglu et al, 2016b and Kurt et al. 2017).

*Pod yield*

The pod yield of the breeding lines varied between 6064 kg $ha^{-1}$ and 9232 kg $ha^{-1}$. The differences between the lines were statistically significant for the pod yield. The average pod yield was 8141 kg $ha^{-1}$. The highest pod yield was obtained from YF-15 (9232 kg $ha^{-1}$) and the lowest from YF-16 (6064 kg $ha^{-1}$) (Table 1). The yield and some agronomic characteristics of peanut are influenced by genotype and environmental conditions during the growing season. Cox (1979), Ketring (1984) and Caliskan et al. (2008), indicated that management practices such as variety selection, time of sowing and growing period of varieties may influence the growth, yield and seed quality of peanut. Canavar and Kaynak (2008) indicated that planting date had a statistically significant effect on pod yield per plant and pod yield per hectare. Arioglu et al. (2016) found that the pod yield was varied between 3830-8790 kg $ha^{-1}$ and the highest pod yield was obtained from Sultan (8790 kg $ha^{-1}$) and Halisbey (7792 kg $ha^{-1}$) varieties. Gulluoglu (2011), Gulluoglu et al. (2016b) and Kurt et al. (2017) reported that the pod yield of Virginia type varieties varies from 6108.5 to 9025.0 kg $ha^{-1}$ in main crop growing season. Canavar and Kaynak (2010) reported that three physiological processes best explain the variation in peanut yields. These are partitioning of assimilate between the reproductive and vegetative structures, the length of the pod filling period and the rate of the pod establishment.

*Fatty acids composition*

The nutritional and storage qualities of peanut are determined by its fatty acids composition. Peanut oil contains saturated and unsaturated fatty acids. The fatty acid composition of peanut is becoming increasingly important diet for healthy living. The nutritional qualities of peanut depend on the relative proportion of saturated and unsaturated fatty acids in the oil. It has been seen in Table 2, the amount of saturated fatty acids such as palmitic (C16:0), stearic (C18:0), arachidic (C20:0) and lignoceric (C24:0) acids in peanut breeding lines varied between 3.69-10.28%, 2.84-33.92%, 0.92-1.36% and 2.35-2.78%, respectively. The unsaturated fatty acids such as oleic (C18:1), linoleic (C18:2) and linolenic (C18:3), acids content in breeding lines varied between 51.97-80.00%, 2.71-28.42% and 1.40-1.69%, respectively. The fatty acid composition of peanut oil varies depending on the genotype, seed maturity, climate conditions, growth location, and interaction between these factors (Carrin and Carelli, 2010). The fatty acids composition of Virginia type peanut varieties varies between 9.0-9.1% palmitic, 2.2-2.4% stearic, 56.4-60.3% oleic, 24.2-26.8% linoleic, 1.1-1.8% arachidic1.0-1.1% eicosenoic and 1.8-2.4% behenic acids (Brown et al. 1975).Peanut oil contains saturated and unsaturated fatty acids. 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. The major fatty acids components are oleic, linoleic and palmitic acids in peanut oil (Chowdhury et al. 2015). Peanut oil is rich in oleic and linoleic acids. The oleic acid content varied between 51.97-80.00% in breeding lines. The oleic acid content was the highest in YF-8 (80.00%).The oleic acid content was 51.64% and 80.03% in Halisbey and Brantley (parents), respectively. The oleic acid content of YF-8 (80.00%), YF-18 (73.04%), YF-1 (70.80%), YF-21 (67.46%) and YF-14 (64.40%) lines were higher than Halisbey. The linoleic acid content varied between 2.71-28.42% in breeding lines. The linoleic acid content was the lowest in YF-8 (2.71%) line. The linoleic acid content of YF-8 (2.71%), YF-18 (9.29%), YF-21 (14.53%) and YF-14 (17.32%) lines were lower than 20% (Table 2). Oleic acid content in peanut genotypes can vary from 21 to 85% and linoleic acid from 2 to 43% (Andersen and Gorbet, 2002). Oleic (a monounsaturated fatty acid) and linoleic (a polyunsaturated fatty acid) account for 75-80% of the total fatty acids in peanut oil (Brown et al. 1975). The results are corresponded well with the findings of Gulluoglu et al. (2016a).

Table 2. Fatty acids compositions of peanut breeding lines

| Breeding lines | Palmitic Acid (%) | Stearic Acid (%) | Oleic Acid (%) | Linoleic Acid (%) | Linolenic Acid (%) | Arachidic Acid (%) | Lignoceric Acid (%) |
|---|---|---|---|---|---|---|---|
| Halisbey | 7.89 | 2.92 | 51.64 | 27.86 | 1.38 | 1.28 | 2.26 |
| Brantley | 5.91 | 3.95 | 80.03 | 3.17 | 1.73 | 1.25 | 2.52 |
| YF-1 | 7.53 | 2.88 | 70.80 | 12.07 | 1.40 | 1.36 | 2.51 |
| YF-2 | 10.10 | 3.12 | 53.64 | 26.55 | 1.49 | 1.01 | 2.57 |
| YF-3 | 9.78 | 3.58 | 55.03 | 25.05 | 1.60 | 0.92 | 2.56 |
| YF-4 | 10.18 | 2.84 | 51.97 | 28.42 | 1.42 | 1.04 | 2.60 |
| YF-5 | 9.97 | 3.28 | 53.99 | 26.33 | 1.51 | 0.99 | 2.50 |
| YF-6 | 9.95 | 3.29 | 53.86 | 26.25 | 1.58 | 1.01 | 2.59 |
| YF-7 | 3.69 | 3.69 | 58.78 | 26.91 | 1.69 | 1.04 | 2.67 |
| YF-8 | 6.07 | 3.92 | 80.00 | 2.71 | 1.84 | 1.26 | 2.78 |
| YF-9 | 10.16 | 3.04 | 53.47 | 26.77 | 1.48 | 1.04 | 2.56 |
| YF-10 | 9.92 | 3.66 | 55.19 | 24.60 | 1.63 | 0.98 | 2.57 |
| YF-11 | 9.82 | 3.46 | 55.91 | 24.23 | 1.58 | 1.00 | 2.55 |
| YF-12 | 9.63 | 3.40 | 55.84 | 24.33 | 1.61 | 1.02 | 2.64 |
| YF-13 | 10.28 | 2.96 | 52.88 | 27.39 | 1.45 | 1.00 | 2.54 |
| YF-14 | 8.50 | 3.11 | 64.40 | 17.32 | 1.49 | 1.15 | 2.55 |
| YF-15 | 9.65 | 3.44 | 56.58 | 23.69 | 1.61 | 1.00 | 2.57 |
| YF-16 | 10.20 | 2.90 | 52.99 | 27.20 | 1.48 | 1.02 | 2.68 |
| YF-17 | 10.24 | 3.06 | 53.45 | 26.56 | 1.49 | 1.06 | 2.63 |
| YF-18 | 7.39 | 3.72 | 73.04 | 9.29 | 1.59 | 1.23 | 2.35 |
| YF-19 | 9.61 | 3.48 | 56.92 | 23.27 | 1.64 | 0.99 | 2.64 |
| YF-20 | 9.91 | 3.11 | 54.70 | 25.59 | 1.54 | 0.98 | 2.67 |
| YF-21 | 8.03 | 3.15 | 67.46 | 14.53 | 1.50 | 1.24 | 2.56 |
| YF-22 | 9.85 | 3.33 | 54.89 | 25.15 | 1.61 | 0.97 | 2.66 |

**Conclusions**

The yield and some agronomic characteristics of peanut are influenced by genotype and environmental conditions during the growing season. The data belonging to pod yield and some agronomic characteristics of breeding lines (F6) were found higher than parents (Brantley and Halisbey). The pod number per plant of breeding lines was between 24.9-34.9 pod plant$^{-1}$, pod weight was 73.3-91.2 g plant$^{-1}$, 100-seed weight was 118.0-148.6 g, shelling percentage was 59.5-66.9% and pod yield was 6064-9232 kg ha$^{-1}$. The oil content and oleic acid percentage of breeding lines were varied between 41.20-55.95% and 51.97-80.00%, respectively. As a result; YF-1, YF-8, YF-14, YF-18 and YF-21 lines can be register as new variety.

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