THE EFFECT OF DIFFERENT SOWING DENSITIES ON YIELD AND SOME YIELD COMPONENTSOFCHICKPEA (CICER ARIETINUM L.) UNDER BINGOL ECOLOGICAL CONDITIONS

Mohammed Hussein AZIZ

MASTER THESIS

Department of Field Crops

Supervisor: Assoc. Prof. Dr. Hasan KILIÇ

2017

REPUBLIC OF TURKEY
BİNGÖL UNIVERSITY
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This thesis was unanimously approved by the following jury on 14.03.2017

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PREFACE

To begin with, I thank (Allah) for his blessing who made me able to complete and perform this study with success. I would like to thank my supervisor, Assoc. Prof. Dr. Hasan KILIÇ for his patience and guidance throughout the project. I would like to acknowledge and thank the presidency of Bingol University, the Deanery of Faculty of Agricultural Sciences and the Department of Field crop for giving me the chance and providing the available facilities to achieve this proposed project. I am also grateful to. Dr.İrfan ERDEMCİ and Mr Yasin DALKILIÇ'in GAP International Agricultural Research and Training Center in Diyarbakir whom they helped me to sieves seeds size. Deepest gratitude to Dr. ALI Mheadin and Dr Mohameed saaid in agriculture college in Halabja for his scientific advices for doing static analysis to data of my thesis. I have special thank to my friends Mr. Aryan Mahmud, Mr. Brzan Merza Ahmad and also for Mr Mozda Jlal and Mr Arsalan Aziz for supporting me during my experimental work in laboratory and plantation Agriculture College in Bingol university. And moral support I would like to extend my deepest appreciation and thanks to my friends in that university, for their encouragement, considerable assistance, and visited me in during the study period. I am also very much grateful to all my family for their love, assistance and encouragement especially my wife and my brothers Mr Aram and Mr.Yousif to find some biological information about plant density, also I thinks full to all of persons whose help me during my MSc study. I Dedication to my mother and my father, my brother and my sisters, my wife Gerda, my daughters and my son, Kak kosrat.

Mohammed Hussein AZIZ

Bingöl 2017

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LIST OF SYMBOL

g	: Gram
kg	: Kilogram
da	: Decar
ha	: Hectare
mm	: Millimeter
cm	: Centimeter
T	: Ton
N	: Nitrogen
P	: Phosphorus
K	: Potassium
CV	: Coefficient of variation
AAS	: Atomic absorption spectra photometer
LSD	: Least significant difference
M	: Meter
Cu	: Copper
Ni	: Nickel
Zn	: Zinc
Fe	: Iron
Al	: Aluminum
Mg	: Magnesium
P	: Phosphorus
K	: Potassium
Na	: Sodium
C	: Carbon
Ca	: Calcium

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BİNGÖL EKOLOJİK ŞARTLARINDA FARKLI BİTKİ SIKLIKLARININ NOHUTTA (*CİCER ARİETİNUM* L.) VERİM VE BAZI VERİM UNSURLARINA ETKİSİ

ÖZET

Bu araştırma çeşit ve ekim sıklığının nohutun (*Cicer arietinum* L.) verim ve verim unsurlarına etkisini belirlemek üzere, 2016 yılında Bingöl ekolojik şartlarında yürütülmüştür. Tesadüf blokları deneme desenine göre tanzim edilen ve üç tekerrürden oluşan çalışmada çeşitler (Arda ve ILC-482) ana parselleri, tohum sıklığı da (20, 30, 40, 50 ve 60 tohum/m2) alt parselleri teşkil etmiştir. Çalışmada, tane verimi ile birlikte verim unsurlarından: çıkış oranı, çiçeklenme gün sayısı, bitki boyu, ana dal sayısı, biyolojik verim, ilk bakla yüksekliği, bitkide bakla sayısı, bin tane ağırlığı, hasat indeksi ve elek üstü oranı (9, 8, 7 ve 6 mm); mikro elementlerden tanede Fe, Ni, Na ve Zn içerikleri incelenmiştir. Çıkış oranı, çiçeklenme gün sayısı, biyolojik verim, bitkide bakla sayısı, 9 mm elek üstü oranı ve tane verimi gibi özelliklerde tohum sıklığının etkisi önemli bulunurken, bitki boyu, ana dal sayısı, bin tane ağırlığı, ilk bakla yüksekliği, hasat indeksi, 8, 7 ve 6 mm elek üstü oranı ile Fe, Ni, Na ve Zn mikro element içeriklerinde ise önemli bir farklılık tespit edilememiştir. Öte yandan başta tane verimi olmak üzere, çıkış oranı, çiçeklenme gün sayısı, ilk bakla yüksekliği, hasat indeksi, 9 mm elek oranı, Fe ve Ni mikroelement içerikleri yönünden çeşitlerin etkisi önemli görülmüştür. Ayrıca çeşit x tohum sıklığı interaksiyonu bakımından da yalnıcza tane verimi ve tane Zn içeriği önemli bulunmuştur. En yüksek tane verimi (86,26 kg/da) ILC-482 nin 60 tohum/m^{-2} sıklığından elde edilirken, en düşük tane verimi de (19,80 kg/da) Arda çeşidinin 30 tohum/m^{-2} tohum sıklığından elde edilmiştir. Arda çeşidi ile mükayese edildiğinde ILC-482 nin bitkide bakla sayısı, bin tane ağırlığı, ana dal sayısı ve hasat indeksi bakımından daha yüksek değerlere sahip olduğu tespit edilmiştir. Tohum sıklığı ile tane verimi arasında tespit edilen linear ilişkinin (Y= 10,7074+07889x) ancak çok yıl ve lokasyonda denenmesi ile tavsiye edilebilir hal kazanabilecektir.

Anahtar Kelimeler: Ekim sıklığı, mikroelement, nohut, tane verimi, verim unsurlar

THE EFFECT OF DIFFERENT SOWING DENSITIES ON YIELD AND SOME YIELD COMPONENTS OF CHICKPEA (CICER ARIETINUM L.) UNDER BINGOL ECOLOGICAL CONDITIONS

ABSTRACT

Investigations to assess the yield and yield components of two chickpea (*Cicer arietinum* L.) varieties to different seeding densities were carried out in 2016 in Bingöl, Turkey. The trial was laid out with split plot arrangement having three replications during 2016. Two varieties i.e. Arda and ILC-482 were in main plots, whereas five chickpea seeding density (20. 30. 40. 50 and 60 seed m^{-2}) were in sub plots. The grain yield per plot and its yield components: number of emergence rate, days to flowering, branch number per plant, biological yield, first pod height, grain yield; number of pod per plant, thousand grain weight, plant height, harvest index, sieves (9. 8. 7. 6. 5 mm) and minerals analyses of Fe. Ni. Na. Zn were evaluated. The results indicated that seeding densities significantly affected various yield and yield components like emergence rate, days to flowering, biological yield, number pods per plant, sieve 9 and grain yield, but plant height, brunch number, thousand kernel weight, first pod height, harvest index, sieves 8 sieves 7, sieves 6, Fe, Ni and Zn were not affected significantly. The varieties differed significantly from emergence rate, days to flowering, firs pod height, harvest index, sieves 9, sieves 8, Fe, Ni and grain yield. Besides, the results showed that the interaction of seed density and variety had significant ($P<0.05$) effect on grain yield and microelement of Zn. Variety ILC-482 produced the maximum grain yield (86.26 kg/da) by 60 seed/m^{-2} and Arda gave the lowest grain yield (19.80 kg/da) by 30 seed m^{-2}. The higher grain yield in ILC-482 was attained due to more number of pods per plant, thousand kernel weight, brunch number and harvest index as compared to Arda, respectively. This showed the possible of increasing the yields of the two varieties in the study area using appropriate seed density. The linear relationship between grain yield and seed density has been obtained asY= 10.774+07889 X. The result of regression and variance analaysis indicated that trial should be carried out more seed densities over many years to give valid recommendation in this area.

Keywords: Chickpea, density, variety, grain yield, yield components, microelements.

1. INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an annual grain legume (pulse) crop sold into human food markets. Chickpea is the third most important food legume crop and India is the largest producer contributing to 65% of world's chickpea production (Faostat 2012). (Hulse 1991) reported that legume is one of the oldest groups of agricultural plants and food legumes are the second most important human's food supply after the cereal grains, which their grain contain 38 to 59% carbohydrate, 25% protein, 4.8 to 5.9% oil, 3% ash, 3% fiber, 0.2% calcium, and 0.3% phosphorus.

Chickpea is grown in over 56 countries, with the highest production in India, Iran, and Pakistan (Faostat 2010). However, some studies show that it is grown across a wide range of environments (Rao et al. 2002), (Siddique et al. 2000). Chickpea is grown mainly in Central Asia, West Asia, South Europe, Australia and North Africa (Ladizinsky and Adler, 1975),(Berger and Turner, 2007). Its foundation is believed to be in south-eastern Turkey neighboring Syria and Iran (Ladizinsky 1975). The earliest residue of chickpea seeds date back to around 7000 B.C in Syria and Turkey. Chickpea annually production was 10.461.215 tons, harvest area was 11.551.857 ha and the yield 905.5 kg/ha in the world(Anonymous 2011). The amount of chickpea production in Turkey was 450.000 tons, harvest area and yield was respectively 388.518 ha and 1158.2 kg/ha. (TUIK 2014).

The use of high plant density in chickpea production decreases soil water evaporation late in the growing season when plant cover closure is low. In difference, low plant density may allow weeds to grow more aggressively and limit crop yield possible. Plants grown at lower plant density are usually shorter and branchy, which increases losses during combine harvest (Turner et al. 2001). In a study in Canada, a plant population density of 55 plants m^{-2} produced a 23% to 49 % seed yield above that of the recommended plant population density of 44 plants m^{-2} (Vanderpuye 2010). Plant population is a type component of the production of chickpea.

The yield of chickpea can be improved by planting of best density of chickpea cultivars. In Iran, yield enhancement was recorded with an increase in population up to 50 plants m^2 under irrigated conditions and up to 25 plants m^{-2} in non-irrigated spring-sown chickpea. One of the main causes of low yield of chickpea (*Cicer arietinum* L.) is population unsuitable. Also, low and high plant density beyond a certain limit often unfavorably affects the crop yield. Number of plants per unit area effect plant size, yield components and finally the grain yield, reported that plant density in the field is also very important to facilitate aeration and light penetration in to plant canopy for improving rate of photosynthesis (Beech and Leach 1989). The objective of this study was to determine the effect of plant density and varieties on yield and some characteristics of chickpea under agro-climatic conditions of Bingol, Turkey.

2. LITERATURE REVIEWS

Norman (1963) reported that yield of a crop depends on the final plant density. The density depends on the germination percentage and the survival rate in the field. Establishment of necessary plant density is important to get maximum yield. For example, when a crop is raised on stored soil moisture under rain fed conditions, high density will deplete moisture before crop maturity.

Van der Maesen (1972) reported that chick peas to be a cool season grain legume of exceptionally high nutritive value and most resourceful food in use. The major producers, India, Pakistan and Turkey, contribute 65%, 9.5% and 6.7% respectively, in the world harvest. While it is a cheap source of protein and energy in the developing world, it is also an important food to the affluent populations to improve major food-related health problems. However, more research is denominated to be necessary for revealing the food and nutriceutical benefit of this important food legume through breeding.

Chickpeas can be grown on a wide range of soil types provided that the drainage is good, and they cannot withstand water logging. For optimum results, clay loams are required. In general, chickpea are moderately sensitive to photoperiod and the vegetative period is shorter in a long days, but short days (9 hours) do not prevent flowering (Kay 1979, Saxena 1979) reported that yield was increased with increasing plant population up to 50 plants m^2 for irrigated chickpea and 23 plants m^{-2} for unirrigated chickpea.

Chickpea growing regions of the world, the average maximum temperature ranges from 21 to 29 °C during the day and from 15 to 25 °C during the night. The crop needs daily mean temperature of above 15°C to allow fertilization of flowers and pod setting (Trang and Giddens 1980). (Miccolis and Scavo 1985) grew 8 chickpea varieties at planting density of (10- 11)plantsm^2 and obtained the highest yield of 0.94 tha with 56 plants m^{-2}. Chickpea is a self pollinated annual plant that can complete its life cycle between 90 and 180 days depending on the usual meteorological conditions. Although, stems are branched, curved or straight, set up to prostrate, and more or less ribbed. Flowers are 4 to 30 mm long and germination is rapid and hypogeal (Saxena and Singh 1987; Williams and Singh 1987) reported that the chickpea is a good source of protein and carbohydrate and its protein quality is better than other legumes for example pigeon pea, black gram and green gram. It also supply some minerals (Ca. Mg. Zn. K. Fe. P) and vitamins like thiamine and niacin.

Singh et al. (1988) planted five chickpea varieties at seeding densities of 10, 55 and 66 m^2 and the highest seed yield was given by tall varieties BG-257 and BG-268 at 66 plant m^{-2} due to more branches plant, pods plant and load-seed weight than other varieties.

Singh and Singh (1989) planted chickpea cultivars H86-143 and H82-2 at seeding densities of 44, 55 and 66 m^2. They reported that in H82-2 seed yield was the highest at density of 44 plants m^2, whereas in H86-143. The seed yield was the highest at a density of 55 plants m^{-2}.

Faqstat (2012) Chickpea third pulse crop, fifth food legume and fifteenth grain crop of the world.

Beech and Leach (1989) grew chickpea at row spacing of 18, 36, 53 and 71 cm with plant population densities of 14, 28, 42 and 56 plants m^{-2} and reported that row spacing had a little effect on above ground dry matter production and seed yield.

Sarwar (1998) reported that plant density significantly influenced the number of branches plant and number of seeds plant, whereas plant height, number of seeds pod,100-seed weight, biological yield, seed yield and harvest index were not affected significantly by row spacing.

Ayaz et al. (1999) reported that the species by population interaction showed that in all four species, the mean seed weight, pods per plant and seeds per pod were inversely related to plant density.

Chickpea seed has 25.3-28.9% protein, 38-59% carbohydrate, 3% fiber, 4.8-5.5% oil, 3% ash, 0.2% calcium and 0.3% phosphorus. Digestibility of protein varies from 76-78% and its carbohydrate from 57-60 % (Hulse 1991).

The plant density population of chickpea depends on many factors such as variety, size of the seed, method of sowing, percentage of germination and agro climatic condition of the area. Large sized seeds of *Kabuli* type chickpea requires higher seeding rate than that of small sized seed of *Desi* type chickpea. The seeding rate even varies with varieties, for example Shasho and Chefe are large sized *Kabuli* type chickpea but their population density differs (Million 1995).

Turner et al. (2001) reported that plant density is largely due to improved water use and water use efficiency. The use of high plant density in chickpea production decreases soil water evaporation early in the growing season when plant canopy closure is low. In contrast, low plant density may allow weeds to develop more aggressively and limit crop yield potential. Plants grown at lower plant density are usually shorter and branchy, which increases losses during combine harvest.

Sharar et al. (2001) found that growth and grain yield response of (*Cicer arietinum* L.) cultivar Paidar-91 to different seeding densities (40. 50. 60. 70 and 80) (kg/ ha) and row spacing (30. 45 and 60 cm) were investigated under field conditions. The seed yield and growth characteristics such as plant height, number of branches plant, number of seeds pod, and 1000-seedweight were influenced significantly by seeding densities. Maximum seed yield of 2299.56 kg/ ha was obtained at seeding density of 70 kg/ha whereas row spacing had no significant effect on plant height seed yield and yield components. For obtaining higher yield of gram cultivar it may be sown in 30 cm apart rows using seed rate of 70 kg/ha.

Solomon (2003) reported that both too narrow and too wide spacing do affect grain yields through competition (for nutrients, moisture, air, radiation, etc) and due to the effect of shading. In the latter case (too wide spacing), yield decrease can occur due to inefficient utilization of the growth factors.

Chickpea growth is: generally a function of environmental factors (such as temperature and solar radiation) and mineral nutrition, along with genotype and production practices (Alamand and Haider 2006).

It is an excellent source of protein, fiber, complex carbohydrates, vitamins, and minerals, as a cash crop for smallholder producers. It also increases livestock productivity as the residue is rich in digestible crude protein content compared to cereals (Kassie et al. 2009).

The regions that have seen a great increase in area harvested under chickpea in the last 14 years include the South East Asia region (by 67%) and the developed countries (rest of the world) (by 48%). Over the same time, the area also increased by 18% in Sub Saharan Africa and marginally in South Asia (less than 1%). Both the Latin American and Caribbean region and Middle East and North Africa regions have seen declining area and production of chickpea in the last 14 years (Akibode and Maredia 2011). In Turkey chickpea serves as a multi-purpose legume. First, it fixes atmospheric nitrogen in soils and thus improves soil fertility and saves fertilizer costs in subsequent crops rotation. It is estimated that 103 kg of nitrogen per year per ha is fixed by chickpea (Faostat 2012).

Chickpea is rich in proteins and serves as an economical source of nutritious food for many poor households. Its seed contains 29% protein, 59% carbohydrate, 3% fiber, 5% oil and 4% ash. (Agajie 2014).

3. MATERIALS AND METHODS

3.1. Description of experimental site

The experiment was conducted between April 4, 2016 and July7, 2016 at Research experiment field of Bingol University located at 38º 48 N latitude and 40º 32 E longitude (10 km South Bingol) and at an altitude of 1090 m. Experimental field location receives annual rainfall of 938 mm and has average annual temperatures of 12.0°C (Anonim, 2016). At Bingol, the rain for the main growing season usually commences after November and terminates in the first week of June. The soil of experiment field is silt.

Figure 3.1. Sowing time

Figure 3.2. Sowing time

3.2. Description of variety used for the study

ARDA: The cultivar Arda is one of the important cultivar of chickpea was used in our study. Arda was properties by obtained correctional Institution that: GAP International Agricultural Research and Education Center Diyarbakir. Registration Year, 2013.

Morphological Characteristics:

Plant height : 64-85 cm
Height of first pod : 33-37 cm
Pod number per plant: 19-28.
Number of seeds per pod 1.7
Plant type : Erect
Days to flowering : 90-103 (winter sowing)
Days to maturity: 163-182 (winter sowing)

ILC-482: Registration Date: 1986, Breeding Place and Year: Diyarbakir – 1983, Variety Owner Organization: GAP International Agricultural Research and Training Center Breeders' Organization: GAP International Agricultural Research and Training Center Morphological Characteristics:

Plant height: 40-45 cm

Height of first pod 20 cm

Pod number per plant: 17-27

Number of seeds per pod , 1-1,5

Plant type: Semi-prostrate

Days to flowering: 140-156 (winter sowing)

Days to Maturity: 170-190 (winter sowing)

Figure 3.3. Measuring plant height

Figure 3.4. Measuring plant height

3.3. Climate Conditions of the Study Area

Compared with the long-term average, 2016 was relatively dry seasons, other meteorological parameters, such as minimum and maximum temperature, humidity and the average annual total rainfall were also collected by a Bingol weather station. Meteorological parameters of experimental area are given in Table 3.1. The annual average monthly minimum and maximum temperature of the district in 2016 are approximately 19.5 °C and 6.4 °C respectively. During the study in 2016, the lowest minimum temperature was fell down below to -5.6 ^{o}C in January. Rainfall is an important factor which affects the land and yield of crops. Bingol has the highest of_ rainfall. The average annual total rainfall is about 933.9 mm in long terms. Total rainfall level of 2016 is lower than the total precipitation level of previous years. But during the first half of 2016, the total of precipitation was higher than the previous years. The amount of rainfall on the chickpea products was 98.4mm.The rain fall in Bingol falls mostly in the winter, with relatively little rain in the summer. In terms of relative humidity values, the temperatures feel hotter because the humidity is usually very high. The average of humidity for the long terms was 56. 6% while for the 2016 was 52. 2 %.

Figure 3.5. Blending of chickpeas

Table 3.1. Selected meteorological parameters of experiment area during 2016

Months	Min temp.(°C)		Max temp.(°C)		Precipitation (mm)		Relative Humidity (%)	
	Long terms	2016	Long terms	2016	Long terms	2016	Long terms	2016
January	-6.1	-5.7	2.1	1.3	133.7	207.8	73.3	75.2
February	-5.3	-1.3	3.5	7.4	132.0	69	72.2	75.6
March	-0.4	2.3	9.2	12.4	125.9	79	64.2	60.7
April	5.7	7.4	16.4	21.1	119.6	43.8	61.2	47.9
May	10.1	10.1	22.8	23.3	75.0	39.2	55.8	57.3
June	14.6	15.6	29.3	29.3	20.7	8.4	42.5	43.9
July	18.9	19.7	34.5	34.8	5.7	7	36.7	33.5
August	18.5	20.4	34.5	36.4	3.3	0	36.8	28.27
September	13.5	13.4	29.6	28.0	11.4	30	42.2	40.9
October	8.1	8.4	21.5	23.8	63.7	3.4	58.9	43.4
November	2.2	0.7	12.4	13.9	109.7	25	64.7	47.3
December	-2.9	-56	5.0	2.3	133.2	186.7	70.7	74.1
Total/Ave	6.4	7.1	18.4		933.9	699.3	56.6	52.2

Source: General Directorate of Meteorology of Bingol (2016).

3.4. Soil Analysis

The most common types of soils found in the chickpea-producing areas are sandy-clay or clay-sandy in texture, with contents of organic matter of around 2.5 to 3.0 % and a pH between 6 and 7.5. Soils with relatively high contents of calcium have been observed in some areas which makes the grain grown under such conditions hard for cooking. Soil samples have been taken from three different points of the study area, from a depth of 0-30 cm, and then the samples were mixed. The analysis of the physical sample was took place at the Bingol University Faculty of Agriculture Department of Soil Science and Plant Nutrition Laboratories. Microelement values were taken from .(Demir 2016).

Table 3.2. Soil analysis result for physical and chemical characteristic of the study area

Soil depth	Soil texture	pH	Salt Content	Organic Matter	P_2O_5	K_2O	Lime	Fe	Zn	Na
Cm			%	%	Kg/ha		%	ppm		
0-30	Loam	6.5	0.0315	1.905	7.9	24.5	0.36	14.15	0.33	0.78

As seen in Table 3.2 the soil texture of the study area was “loamy”, with “mildly acidic pH, no salinity, levels of lime, organic matter ratio was low, phosphor ratio was average and potassium ratio was sufficient.

3.5. Soil preparation

Depending on the extension of the area and the economic resources of the farmer, soil prepared traction, consisting in both cases of a single plowing in April or May when the first heavy rains fall, or by the beginning of September when the winter rains start to decrease. By mid-September the soil is harrowed once or twice and is ready for sowing total Cu cconcentration.

3.6. Fertilization

Chickpea like most annual legumes, can provide a part of its own N necessity through interdependent N_2 fixation when the plants are inoculated. (Sosulski and Buchan 1978) reported that rhizobia inoculation alone is not enough for attaining highest yields of legumes because of poor root and nitrogenize doing. They concluded that annual legumes may require a high level of plant N fertility to achieve maximum yield. Also**,** in this study, the whole dose of P (6 kg P da^{-1}) with one third dose of nitrogen (7.5 kg N da) were applied at sowing time and the remaining nitrogen (5 kg N da) was top-dressed as Ammonium nitrate (33 %) with flowering time on 26 July,2016. Rhizobium bacteria nodules were not observed in the roots of chickpea parcels weeds were controlled by hand after germination.

Figure 3.6. Harvest time

Figure 3.7. Harvest time

3 .7. Treatments and experimental design

Two factorial trial was set up as a split-plot design (RCBD) with comparing two chickpea varieties (Arda and ILC-482) as main plots and five seed densities (20, 30, 40, 50 and 60 seed m^{-2}) as split-plots. The main plots were randomized in a block design with three replications. The density treatments were randomized in the sub plots. Each variety was sown in four-row plots of 5 m length with between- and within-row spacing of 30 cm. Plot size was 1.2 m x 5 m (6 m^2). Spacing of 0.4 m and 1 m were allocated between plots and blocks, respectively.

3.8. Data collection and measurement

Emergence rate were taken as the number of days from planting to the period when 50 % of the plants in a plot emerged above the ground.

Days to flowering were determined as the number of days from planting to the period when 50 % the plants in plot developed first flower.

Plant height was measured from the ground to the tip of main stem of the plant using a ruler from randomly taken ten plants per plot at physiological maturity.

Branch number per plant was determined by counting the number of branches that grow on the main stem of ten randomly taken plants per plot at the time of maturity.

Number of pods per plant was recorded by counting the total number of pods of ten randomly taken plants from the net plot area at harvest.

Biological yield was determined by drying and uprooting the above ground biomass from the whole net plot area in an open air (including the seed yield) and weighing using spring balance.

Thousand grain weight was determined by weighing randomly taken dry seeds using sensitive balance and the weight was adjusted to 10 % moisture level.

Grain yield was measured from the air-dried seeds of the net plot area using sensitive balance and adjusted at 10% seed moisture content.

Harvest index % was computed as the ratio of seed yield to biomass yield.

3.9. Mineral analysis

Fe, Ni, Zn and Na compositions of whole chickpea flour were determined by the method of (Hwang et al. 1997) (Choi et al. 2013) with slight modifications. One gram of chickpea flour was wet-digested in a mixture solution of HNO_3 (10 mL) and H_2SO_4 (10 ml) with heating on a hot plate. After extraction cooled, in hood opening carefully to pass the gas and put it to another tub that contain nearly 5 ml of distilled water slowly and completed to 25 ml by distilled water. This solution was ready for using to determine elements. Fe, Ni and Zn minerals determined by atomic absorption spectrophotometry (Perkin Elmer, AAS 800).

Figure 3.8. image mierals analyses in laboratory

3.10. Statistical data analysis

The various agronomic data collected were subjected to analysis of variance (ANOVA) Appropriate to factorial arrangement in RCBD according to the Generalized Linear Model (GLM) of SAS and interpretations were made following the procedure described by (Gomez and Gomez 1984). Whenever the effects of the factors and interactions were found to be significant, the means were compared using the least significant differences (LSD) test at 5% level of significance. Regression analysis was conducted to estimate linear and quadratic effects of plant density when results of the analysis of variance indicated these effects were significant at $P < 0.05$. Data from sieve 9 mm wasn’t distributed normally, and therefore transformed as √+1 before the data were subjected to an analysis of variance.

4. RESULT AND DISCUSSION

4.1. Emergence rate%

The results of the emergence rate are presented in Table 4.1 Table 4.2 Fig 4.1 and Fig. 4. 2. Emergence rate is one of the phonological stage in development of chickpea. Were taken as the number of days from planting to the period when 50 % of the plants emerged above the ground. İn this stage was significant difference on variety and density but non - significant difference on interaction. The emergence rate development of chickpeas is influenced by both temperature and photo period. In our study the seeds was emerged after 12 days on (18 April 2016). Table 3 and Figure 9 show the relationship of emergence rate and densities for the two varieties studied. The highest emergence rate has been obtained from ILC482 variety (75.27) by 30 plant m^2. The lowest emergence rate has been obtained from Arda variety (46.77) by 40 plant m^2.

Table 4.1. Analysis of variance of emergence rate of different chickpea and varieties seed densities

Sources	Degrees of Freedom	Sum squares	Mean squares	F Ratio	Prob> F
Replication	2	392.52	196.26	7.4164	0.1188
Variety	1	1344.1	1344.1	50.794	0.0191*
Replication x variety Random(Error1)	2	52.925	26.463	0.6139	0.5535
Density	4	535.71	133.93	3.107	0.0453 *
Variety*density	4	185.23	46.308	1.0743	0.4016 ns
Error-2	16	689.67	43.105		
C. Total	29	3200.2			
CV%	1.06				

*Significance at 5 % probability, **Significance at 1 % probability, ns = non-significant.

Successful germination and emergence are the primary requirements for good crop establishment. Controlled environment studies have shown that chickpea seed germination can occur over a range of temperatures above a base temperature, reported to be 0 °C, but is fastest at around 32°C. (Covell et al. 1986). (Saxena 1987) the major factors controlling the time taken by a crop to emerge. After emergence it is temperature and photoperiod.

Table 4.2. Effect of varieties and seeding density on emergence rate (%) of chickpea

Varieties	**Densities** (Seeds m^{-2})					**Means**
	20	30	40	50	60	
Arda	52.69	54.48	46.77	58.49	51.97	52.88 b
ILC-482	68.82	75.27	57.53	64.52	65.22	66.27 a
Means	60.75 a	64.87 a	52.15b	61.51a	58.59 ab	59.575
LSD(0.05) variety	8.07*					
LSD (0.05) Density	7.99*					
LSD (0.05) varietydensity	Ns					

Means in columns and rows followed by the same letters are not significantly

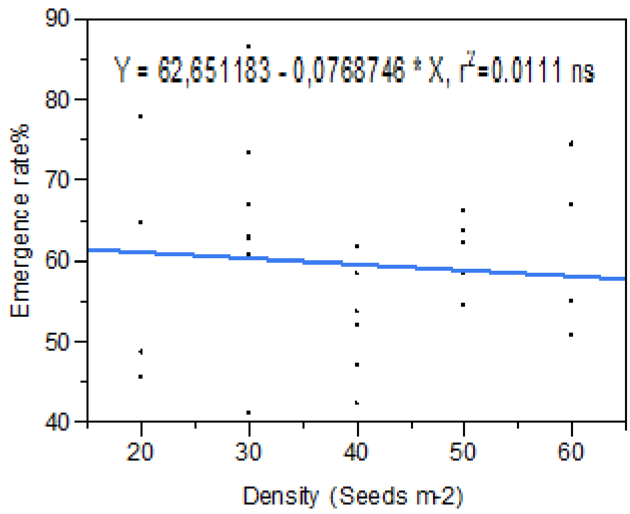

Figure 4.1. Relationship between seed density and the days to emergence rat for chickpea in Bingöl conditions (Regression equation was not significant)

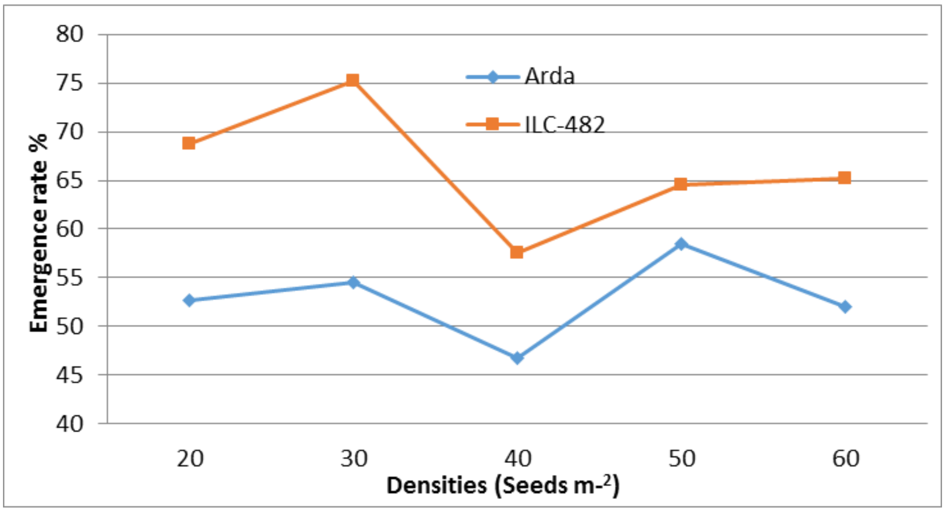

Figure 4.2. Emergence rate for two chickpeas at five s eeding densities

4.2. Days to flowering 50%

The results of the Days to flowering are presented in Table 4.3 Table 4.4 Fig 4.3 and Fig 4.4. İn our study the main effect of variety and density was significant ($P<0.05$) while their interaction had no significant effect on days to flowering (Table 5) Days to flowering were determined as the number of days from planting to the period when 50 % of the plants in a plot developed first flower. Phonological development of the crop was monitored at two to three daily interval for all seasons from the beginning of flowering. Flowering is important stage in lifestyle and phonological stage of chickpea. Also, the flowering effect by intro factor in seeds and time sowing. However, in our study the days to flowering of ILC-482 were started at 25 May 2016. But while Arda has not flowering caused by the variety, temperature and environment. It flowered on 9 June, 2016 . The highest days to flowering has been obtained from Arda variety (47.70 %) by 20 plant m^2. The lowest number of days to flowering has been obtained from ILC-482 variety (39.30%) by 40 to 50 seeds m^{-2}. This might be due to the fact that lower densities had a better light interception as compared to the narrower row spacing resulting in less number of days to flower as chickpea needs direct sunlight reporting for its various physiological processes. On the other hand, in narrower density due to competition for nutrients. Although, this result was in accordance with. (Roberts et al. 1985) have reported that base temperature is a function of photoperiod, hence, the longer the photoperiod at any given temperature the faster the thermal sum required for flowering is accumulated.

Table 4.3. Analysis of variance of days to flowering of different chickpea varieties and seed densities

Variance Sources	**Sum Squares**	**Mean Squares**	**Degrees of Freedom**	**F Ratio**	**Prob> F**
Replication	5.26667	2.63333	2	0.5683	0.6376
Variety	396.033	396.033	1	85.4748	0.0115 *
Replication*variety&Random (Error 1)	9.26667	4.63333	2	21.3846	<.0001
Density	8.86667	2.21667	4	10.2308	0.0003 **
Variety*density	2.46667	0.61667	4	2.8462	0.0587 ns
Error-2	3.46667	0.2167	16		Prob> F
C. Total	425.3667		29		<0.0001
CV%	10.97				

*Significance at 5 % probability **Significance at 1 % probability ns = non-significant.

Table 4.4. Effect of varieties and seeding density on days to flowering (50 %) of chickpea

	Densities (Seeds m^{-2})					
Varieties	20	30	40	50	60	Means
Arda	47.70	47.30	47.30	47.00	46.70	47.20 a
ILC-482	41.30	40.30	39.30	39.30	39.30	39.90 b
Means	44.50 A	43.80 B	43.30 BC	43.20 C	43.00 C	43.56
LSD variety	3.37**					
LSD Density	0.565*					
LSD variety x densityinter.	Ns					

Means in columns and rows followed by the same letters are not significantly.

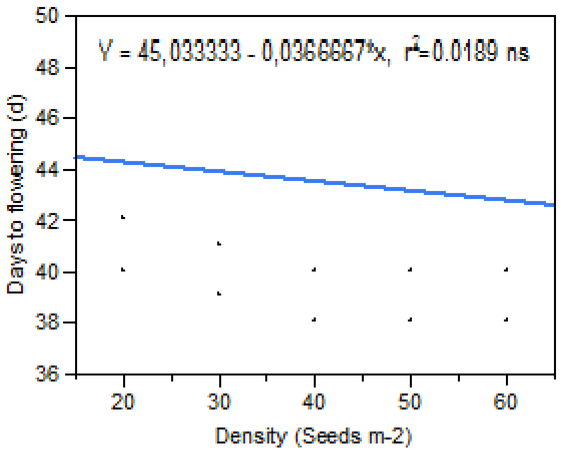

Figure 4.3. Relationship between seed density and the days to flowering for chickpea in Bingol conditions (Regression equation was not significant)

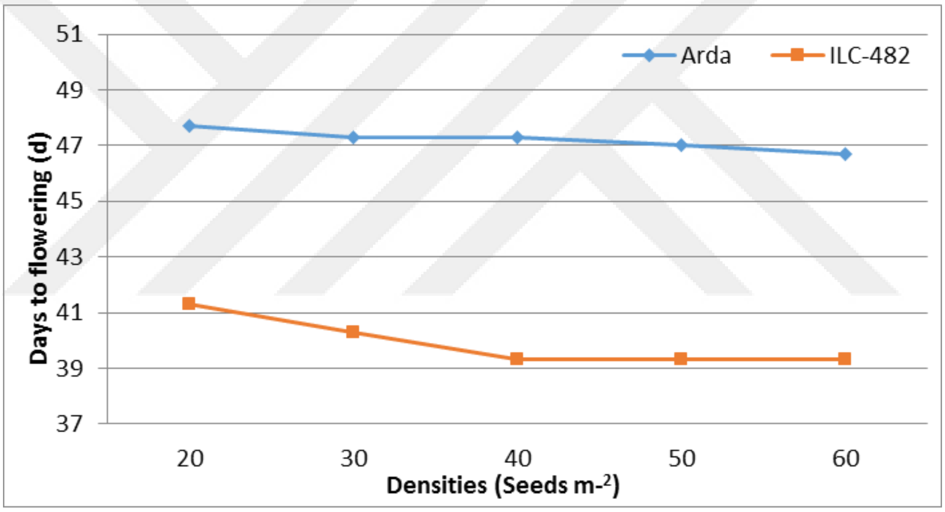

Figure 4.4. Days to flowering for two chickpeas at five seeding densities

4.3. Plant height (cm)

In our study of variance showed significant differences ($P<0.05$) due to the main effects of variety on plant height at 90 % physiological maturity. As the Table 4.5 and Table 4.6 Figure 4.5 suggests, the highest plant height has been obtained from Arda variety (37.23 cm) by 20 plant m^{-2}. It has been followed by variety ILC-482 (36.0 cm) though the lowest plant height has been obtained from variety ILC-482 (32.93 cm) by 40 plant m^2. Variety Arda was significantly taller than variety ILC-482 (Table 7). The variation in height may be due to genetic character of the varieties for this trait. This outcome was in agreement with (Shamsi 2009).

(Cokkizgin 2012) and(Rasul et al. 2012) who showed significant differences between the genotypes of chickpea in plant height. Relationship between genotype and plant density for plant height is presented in Figure 5

Table 4.5. Analysis of variance Plant height of different chickpea varieties and seed densities

Sources	Sum Squares	Mean Squares	Degrees of Freedom	F Ratio	Prob> F
Replication	3.46667	1.73333	2	0.1701	0.8547
Variety	3.888	3.888	1	0.3815	0.5998
Replication*variety &Random(Error-1)	20.384	10.192	2	1.2139	0.3230
Density	37.9513	9.48783	4	1.1300	0.3774
Variety*density	10.2687	2.56717	4	0.3058	0.8699
Error-2	134.33600	8.39600	16		
C. Total	210.29467		29		0.7423
CV%	8.27566				

*Significance at 5 % probability **Significance at 1 % probability ns = non-significant.

Table 4.6. Effect of varieties and seeding density on plant hight of chickpea

Varieties	**Densities** (Seeds m^{-2})					**Means**
	20	30	40	50	60	
Arda	37.23	33.40	35.20	36.10	34.93	35.37
ILC-482	35.60	33.33	32.93	35.40	36.00	34.65
Means	36.41	33.36	34.06	35.75	35.46	35.01
LSD variety	Ns					
LSD Density	Ns					
LSD variety x density inter.	Ns					

Means in columns and rows followed by the same letters are not significantly

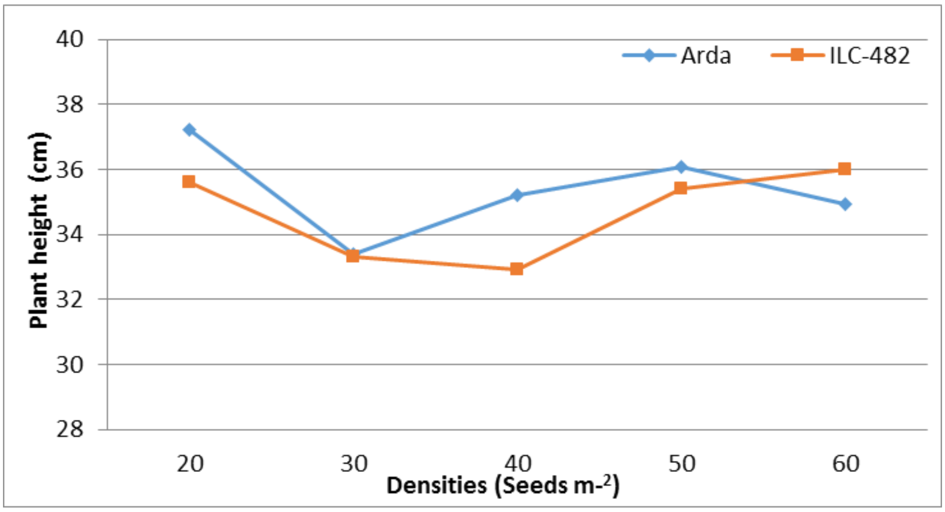

Figure 4.5. Plant height for two chickpeas at five seeding densities

4.4. Branch number per plant

Branching is basically a genetic character and plays an important role in enhancing seed yield. The main effects of variety, density and the interaction effects of variety x density had non-significant influence on the branch number per plant. However, the results of the Branch number per plant are presented in Table 4.7 Table 4.8 Fig 4.6. The highest branch number has been obtained from ILC-482 variety (3. 60) by 30 seed m^{-2}. However, the lowest branch number has been obtained from Arda variety (2.40) by 50 seed m^{-2}. (Singh et al. 1979). Whereas (Togay et al. 2005) and (Bakry et al. 2011) reported that the number of branches decreased with the increase in density. (Abbas 1990) (Sarwar 1998) and (Shamsi 2009) reported that the numbers of branches plant were significantly affected by different plant density. The number of branches determines the total number of leaves, and hence the total photosynthetic area. Relationship between genotype and plant density for branch number is presented in Figure 6 .

Table 4.7. Analysis of variance of branch number per plant of different chickpea varieties and seed densities

Sources	Sum Squares	Mean Squares	Degrees of Freedom	F Ratio	Prob> F
Replication	0.64467	0.32233	2	0.9918	0.5021
Variety	2.523	2.523	1	7.7631	0.1083
Replication*variety&Random (Erro-1)	0.65	0.325	2	1.8625	0.1874
Density	1.15867	0.28967	4	1.6600	0.2082
Variety*density	0.46533	0.11633	4	0.6667	0.6243
Error-2	2.7920000	0.174500	16		
C. Total	8.2336667		29		0.0499
CV%	13.377419				

* Significance at 5 % probability **Significance at 1 % probability ns = non-significant.

Table 4.8. Effect of varieties and seeding density on branch number of chickpea

	Densities (Seeds m^{-2})					**Means**
Varieties	20	30	40	50	60	
Arda	3.26	2.93	2.60	2.40	2.73	2.78
ILC-482	3.40	3.60	3.40	3.20	3.23	3.36
Means	3.33	3.26	3.00	2.80	2.98	3.08
LSD variety	ns					
LSD Density	ns					
LSD.variety.x density inter.	ns					

Means in columns and rows followed by the same letters are not significantly

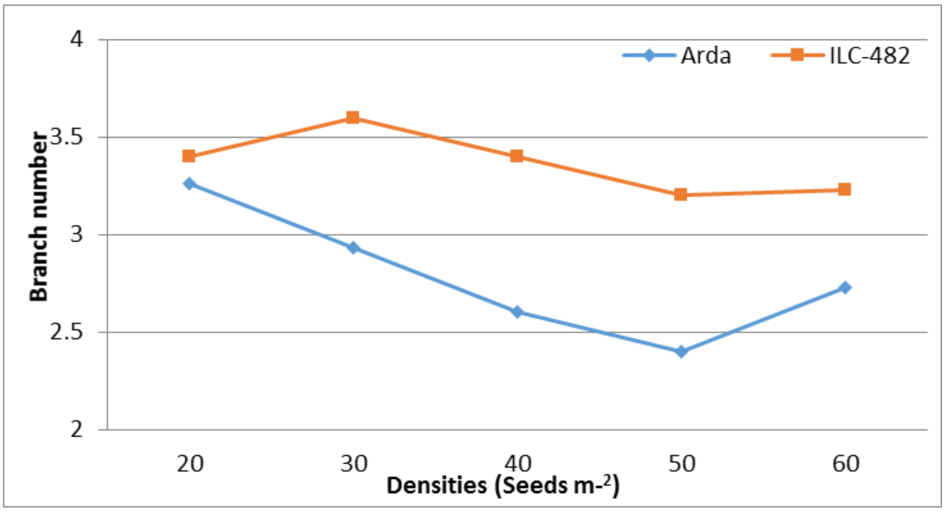

Figure 4.6. Branch number for two chickpeas at five seeding densities

4.5. Biological (kg/da)

The variance analysis results of the biological yields of different chickpea varieties are given in Table 4.9 and Table 4.10. Fig 4.7. Fig 4.8 below. The main effects of variety and the interaction effects of variety x density had non-significant influence on the biological yield. However, density had significant influence on the biological yield. As the study suggests, the lowest biological yield has been obtained from Arda variety (84.54 kg/ da) by 30 seed m^{-2}. While, the highest biological yield has been obtained from variety of ILC-482 (207.45 kg/da) by 60 seed m^{-2}. The decrease in biological yield of variety Arda due to low branching habit might have been compensated by the increase in other parameter. This results might be the reason for the non-significant difference in biological yield among the varieties. This idea was also in agreement with (Singh and Singh 2002) who reported that the yield per unit area was increased with increasing plant density due to efficient utilization of growth factors. Plant density studies in chickpeas suggest that a plant population of 33 plants m^2 is optimal for seed production. (Machado et al. 2003) revealed that biological and grain yield was increased when the seeding rate was increased from 17 to 33 seed m^2 in this study biological yield was increased with increasing in plant density up to a limit, as in biological yield is presented in Figure 15 and Figure 16.

Table 4.9. Analysis of variance of biological yield(kg/da)different chickpea varieties and seed densities.

Sources	Sum Squares	Mean Squares	Degrees of Freedom	F Ratio	Prob> F
Replication	837.038	418.519	2	0.2351	0.8097
Variety	7634.13	7634.13	1	4.2877	0.1742
Replication*variety &Random (Error-1)	3560.93	1780.46	2	2.1173	0.1528
Density	22434.3	5608.57	4	6.6696	0.0023*
Variety*density	2935.45	733.863	4	0.8727	0.5017
Error-2	13454.586	840.91	16		
C. Total	50856.410		29	0.111	
CV%	20.53				

* Significance at 5 % probability **Significance at 1 % probability ns = non-significan.

Table 4.10. Effect of varieties and seeding density on biological yield(kg/da) of chickpea

	Densities (Seeds m^{-2})					
Varieties	20	30	40	50	60	**Means**
Arda	105.98	84.54	134.54	143.85	157.20	125.22
ILC-482	127.42	136.34	133.46	180.97	207.45	157.13
Means	116.70C	110.44C	134.00 BC	162.41AB	182.32A	141.175
LSD variety	ns					
LSD Density	35.48*					
LSD variety x density inter.	ns					

Means in columns and rows followed by the same letters are not significantl

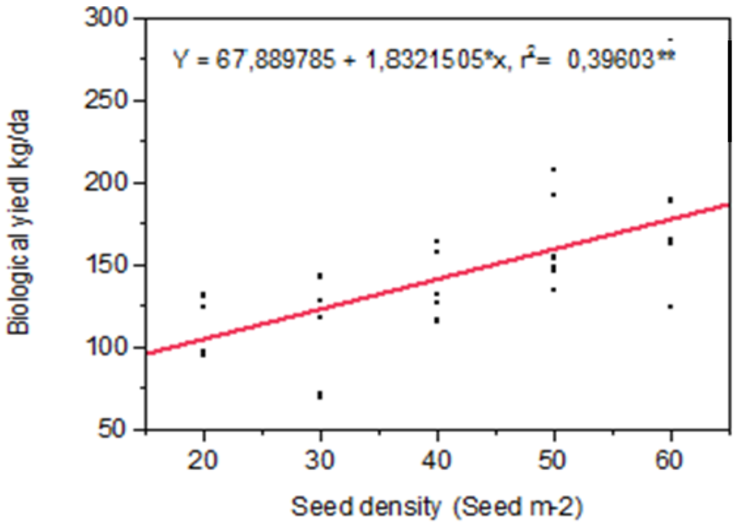

Figure 4.7. Biological yield of chickpea with different seed on densities in Bingol (Equations with slope was non- significant at *P*< 0.01).

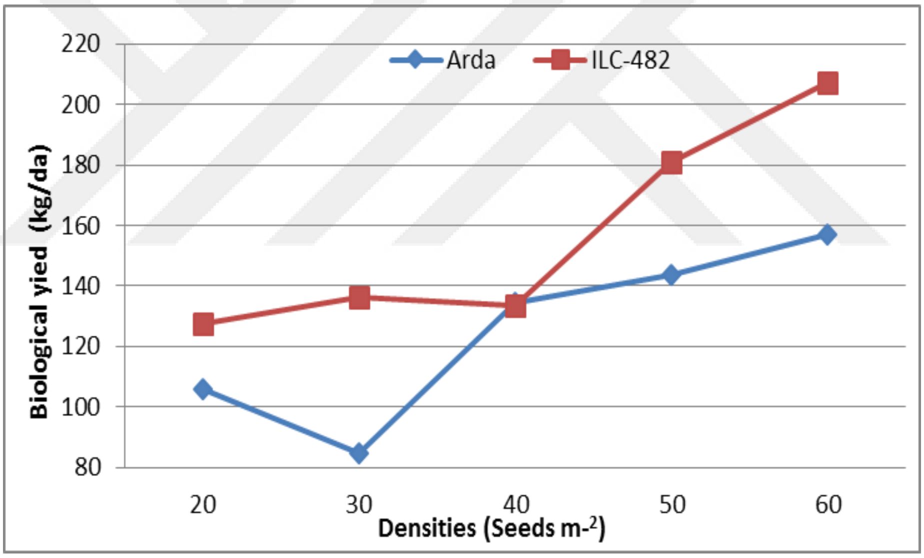

Figure 4.8. Biological yield for two chickpeas at five seeding densities

4.6. Thousand grain weight

In this study the main effects of variety, density and interaction had non-significant influence on the thousand grain weight. As the Table 4.11 Table 4.12 and Figure 4.9. Suggests, the highest thousand kernel weight has been obtained from Arda variety by (316.66 g) in 60 seed $m^{2.}$ Which was followed by Arda variety (300 g) by 50 seed m^2. Also, the lowest thousand kernel weight has been obtained from ILC-482 variety

(256.66g) by 30 seed m^{-2}. The biggest seeds weight were produced by plants at the lowest densities and the smallest seeds weight at the highest densities This can be explained by increased competition among plants. However (Zahoor 1991) reported that thousand kernel weight, biological yield, seed yield and harvest index were not significantly influenced by different seeding densities of chickpea.

Table 4.11. Analysis of variance of of thousand grain weight of different chickpea varieties and densities

Sources	**Sum Squares**	**Mean Squares**	**Degrees of Freedom**	**F Ratio**	**Prob> F**
Replication	2746.67	1373.33	2	1.6885	0.3720
Variety	1763.33	1763.33	1	2.1680	0.2788ns
Replication*variety&Random (Error-1)	1626.67	813.333	2	1.2020	0.3263
Density	4586.67	1146.67	4	1.6946	0.2003ns
Variety*density	4986.67	1246.67	4	1.8424	0.1701ns
Error-2	10826.667	676.67	16		
C. Total	266536.667		29	0.1354	
CV%	9.55183226				

*Significance at 5 % probability, **Significance at 1 % probability, ns = non-significant.

Table 4.12. Effect of varieties and seeding density on thousand grain weight (g) of chickpea

Varieties	Densities (Seeds m^{-2})					Means
	20	30	40	50	60	
Arda	250.00	273.33	260.00	300.00	316.66	280.00
ILC-482	266.66	256.66	270.00	263.33	266.66	264.66
Means	258.33	265.00	265.00	281.66	291.66	272.33
LSD(0.05) variety	ns					
LSD(0.05) Density	ns					
LSD(0.05) variety x density inter.	ns					

Means in columns and rows followed by the same letters are not significantly

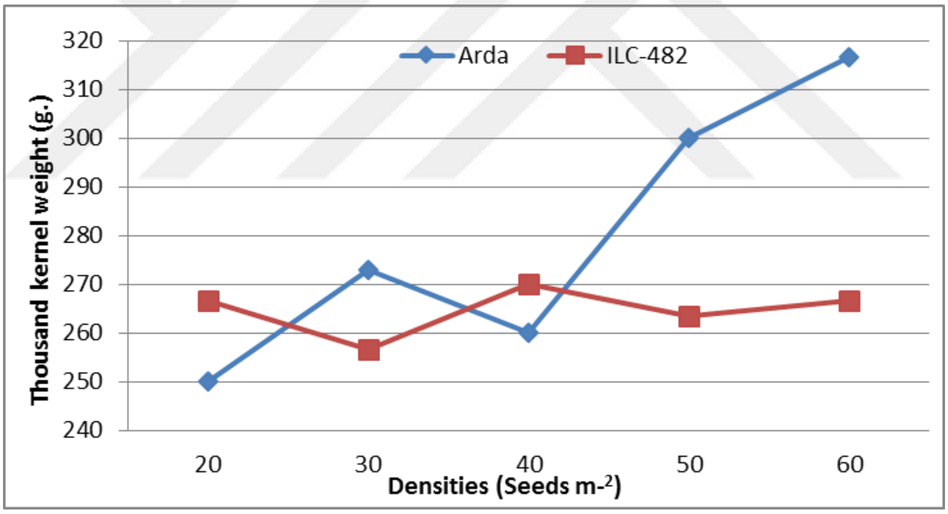

Figure 4.9. Thousand grain weight for two chickpeas at five seeding densities

4.7. First pod height

The results of the first pod high are presented in Table 4.13 Table 4.14 and Figure4.10 indicated that first pod height was non significantly affected by different seeding densities but significantly affected by different varieties. The highest first pod has been obtained from Arda variety (20.26 cm) by 60 seed m-^{2}. While the lowest first pod has been obtained from ILC-482 (14.86 cm) by 20 seed m^{-2}. The first pod height was decreased when the plant density decreased, which shows that first pod height parallel with plant height. The findings are in line with those of (Ozgun et al. 2004). However, (Vanderpuye 2010) reported that lowest pod height increased significantly with increasing Plant Population Density.

Table 4.13. Analysis of variance of first pod height of different chickpea varieties and densities

Sources	**Sum Squares**	**Mean Squares**	**Degrees of Freedom**	**F Ratio**	**Prob> F**
Replication	11.5087	5.75433	2	1.3732	0.4214
Variety	163.8	163.8	1	39.0900	0.0246*
Replication*variety &Random(Error-1)	8.38067	4.19033	2	2.1354	0.1507
Density	4.97467	1.24367	4	0.6338	0.6457ns
Variety*density	3.428	0.857	4	0.4367	0.7802ns
Error-2	31.39733	1.9623	16		
C. Total	223.48967		29		0.0001
CV%	7.930754				

*Significance at 5 % probability, **Significance at 1 % probability, ns = non-significant.

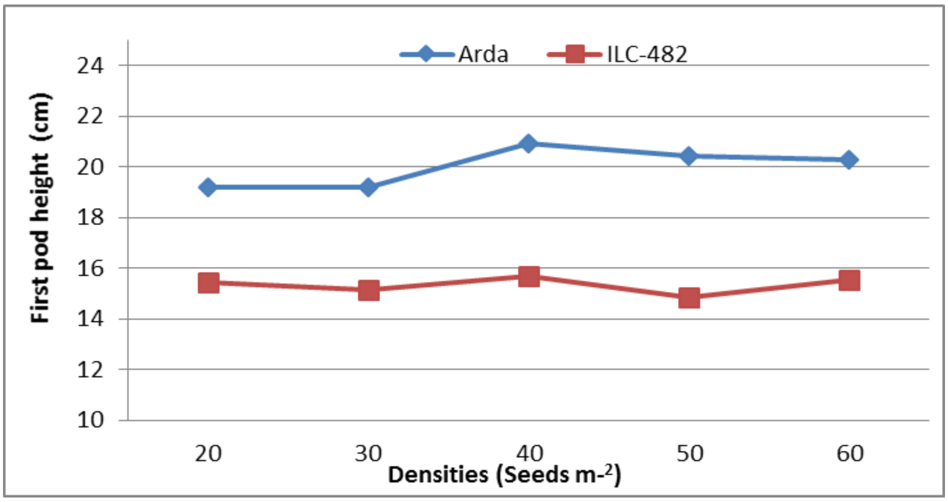

Figure 4.10. First pod height for two chickpeas at five seeding densities

Tabe 4.14. Effect of varieties and seeding density on first pod height of chickpea

	Densities (Seeds m^{-2})					**Means**
Varieties	20	30	40	50	60	
Arda	19.20	19.20	20.93	20.400	20.26	20.00 **a**
ILC-482	15.43	15.13	15.66	14.86	15.53	15.32 **b**
Means	17.31	17.16	18.30	17.63	17.90	17.66
LSD variety	3.21 *					
LSD Density	ns					
LSD variety x density inter.	ns					

Means in columns and rows followed by the same letters are not significantly

4.8. Number of pods per plant

Table 4.15.Table 4.16 indicated that number of pods per plant was non significantly affected by different seeding densities and interaction but significantly affected by different varieties. Number of pods per plant is a key factor for influential the yield show in leguminous plants. The productive capacity of chickpea is finally dependent on the number of fertile pods plant. Analysis of variance showed that varieties highly significantly differed (P<0.5) for number of pods per plant (Table 4.15 .Table 4.16 and Fig 4.11).The highest number of pods per plant has been obtained from variety of ILC-482 (13.20) by 50 seed m^2. And the lowest number of pods per plant has been obtained from variety of Arda (6.46) by 60 seed m^2.The differences in number of pods plant might have been caused due to varietal differences. The greatest number of pods/plant are usually .obtained at low densities (Singh et al. 1997) with the number decreasing with increased plant density (McKenzie 1995) (Thakur et al. 1998). Number of pods per plant was decreased with increasing in seed density was presented in Figure 9. Our result is similar to those of (Singh et al. 1997) and (Frade and Valenciano 2005), respectively.

Table 4.15. Analysis of variance of of number of pods per plant of different chickpea varieties and densities

Sources	Sum Squares	Mean Squares	Degrees of Freedom	F Ratio	Prob> F
Replication	0.84267	0.42133	2	0.1240	0.8897
Variety	90.1333	90.1333	1	26.5306	0.0357*
Replication*variety &Random(Error-1)	6.79467	3.39733	2	0.7548	0.4861
Density	44.7787	11.1947	4	2.4872	0.0850
Variety*density	16.6933	4.17333	4	0.9272	0.4727
Error-2	72.01600	4.5010	16		
C. Total	231.25867		29		0.0303
CV%	20.45				

*Significance at 5 % probability, **Significance at 1 % probability, ns = non-significant.

Table 4.16. Effect of varieties and seeding density on number of pods per plant of chickpea vvarieties

Sources	Densities (Seeds m^{-2})					**Means**
	20	30	40	50	60	
Arda	11.86	8.26	8.53	8.06	6.46	8.64 **B**
ILC-482	12.73	12.66	11.40	13.2	10.53	12.10 A
Means	12.300	10.46	9.96	10.63	8.50	10.37
LSD variety	2.89 *					
LSD Density	Ns					
LSD variety x densityinter	Ns					

Means in columns and rows followed by the same letters are not significantly

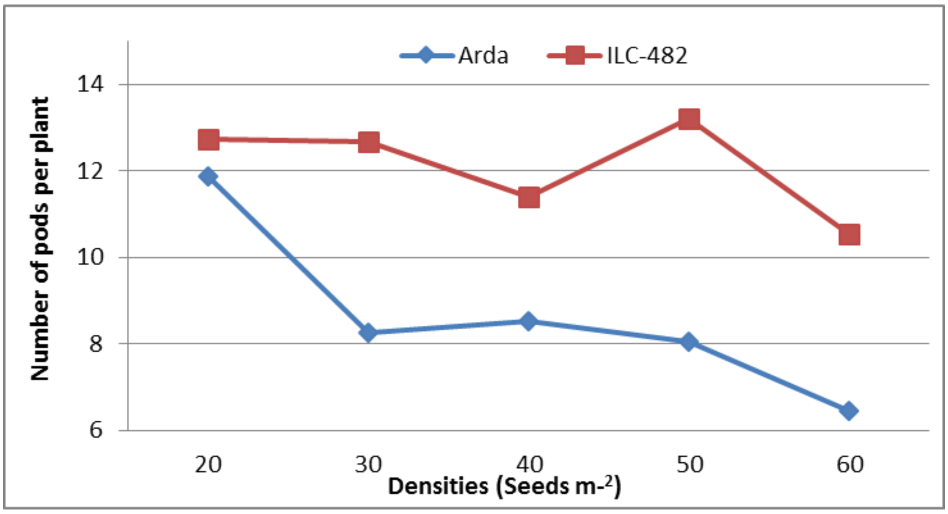

Figure 4.11. Number of pods per plant for two chickpeas at five seeding densities

4.9. Harvest index (%)

The analysis of variance of the harvest index are given in Table 4.17 . Table 4.18 and Fig 4.12 below. Tables showed that the variety had significant difference by seeding density but the interaction and density had non-significant influence on the harvest index. However, as the Table 19 and Table 20 suggested that the highest harvest index has been obtained from ILC-482 (37.95) % by 40 seed m-^{2}. Also, followed respectively harvest index has been obtained from variety of ILC-482 (37.10) % by 60 seed m-^{2}. While, the lowest harvest index has been obtained from Arda variety (17.14) % by 60 plant m^{2}. The similar result was reported that by (Zahoor 1991) 1000 seeds weight and harvest index were not significantly influenced by different seeding densities. However, (Kamithi et al. 2009) reported that the harvest index of chickpea increased with an increase in plant population. Relationship between genotype and plant density for harvest index is presented in Figure 12.

Table 4.17. Analysis of variance of harvest index % of different chickpea varieties and densities

Sources	**Degrees of Freedom**	**Mean Squares**	**Sum squares**	**F Ratio**	**Prob> F**
Replication	2	97.739	48.8695	1.9414	0.34
Variety	1	1752.54	1752.54	69.6205	0.0141*
Replication*variety &Random (Error-1)	2	50.3455	25.1727	1.3449	0.2885
Density	4	18.3621	4.59054	0.2453	0.9083
Variety*density	4	152.321	38.0803	2.0345	0.1378
Error-2	16	299.4806	18.718		Prob>
C. Total	29	2370.788			
CV%	15.72				

*Significance at 5 % probability, **Significance at 1 % probability, ns = non-significant

Table 4.18. Effect of varieties and seeding density on harvest index of chickpea

Varieties	Densities (Seeds m^{-2})						Means
	20	30		40	50	60	
Arda	22.69	20.64	19.54		19.18	17.14	19.83 B
ILC-482	30.16	33.81	37.95		36.56	37.10	35.12 A
Means	26.42	27.22	28.87		27.87	27.12	27.47
LSD(0.05) variety	7.87**						
LSD (0.05) Density	ns						
LSD (0.05) variety, density	ns						

Means in columns and rows followed by the same letters are not significantly

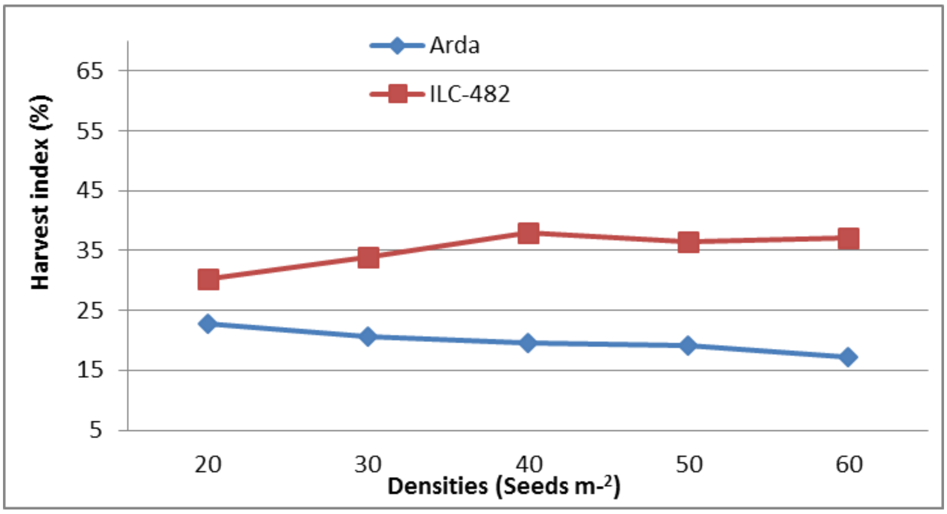

Figure 4.12. Harvest index for two chickpeas at five seeding densities

4.10. Grain yield (kg/da)

Table 4.19 Table 4.20 and Fig 4.13.Fig 4.14 revealed that there were highly significant ($P<0.01$) differences among the varieties and seed densities. The interaction between the two factors was, however, significant. Variety ILC-482 produced the maximum grain yield (86.26 kg/da) by 60 seeds m^2 and Arda gave the lowest grain yield (19.80 kg/da) by 30 seeds m^2. The higher grain yield in ILC-482 was attained due to higher number of total tillers and fertile tillers, more number of pods per plant, thousand grain weight, branch number and harvest index as compared to Arda.

Table 4.19. Analysis of variance of grain yield (kg/da) of different chickpea varieties and densities

Sources	Sum Squares	Mean Squares	Degrees of Freedom	F Ratio	Prob> F
Replication	30.5258	15.2629	2	0.1695	0.8551
Variety	8768	8768	1	97.3843	0.0101**
Replication*variety&Random (Error1	180.07	90.035	2	1.4701	0.2594
Density	3833.93	958.483	4	15.6501	<.0001**
Variety*density	1628.31	407.078	4	6.6468	0.0024**
Error-2	979.915	61.24	**16**		
C. Total	15420.756		29	0.001	

*Significance at 5 % probability, **Significance at 1 % probability, ns = non-significant.

(Gan et al. 2003) concluded that increasing yield of chickpea at high density and they found strong positive relationship between seed yield and plant population densities. (Bahr 2007) also noticed that high plant density (50 plants m^{-2}) gave higher seed yield as compare to low plant density (26 plants m^{-2}) in chickpea. Grain yield was increased with increasing in seed density was presented in Figure 10 and Figure 11. These results are in line with those of (Valimohammadi et al. 2007) reported that plant density has no significant effect on yield. While, (Shamsi 2011) and (Gana et al. 2007) reported that density does not have a significant effect on yield of chickpea.

Table 4.20. Effect of varieties and seeding density seed yield(kg/da) on of chickpea

Varieties	**Densities** (Seeds m^{-2})					**Means**
	20	30	40	50	60	
Arda	22.48	19.80 e	24.43 de	25.69 de	33.41 **cd**	25.16 B
ILC-482	32.71cde	46.02 c	62.86 b	68.93 b	86.26 **a**	59.36 A
Means	27.59 C	32.91 C	43.64 B	47.31 B	59.84 A	42.26
LSD variety	14.89 **					
LSD Density	9.57*					
LSD variety x density inter.	13.54**					

Means in columns and rows followed by the same letters are not significantly

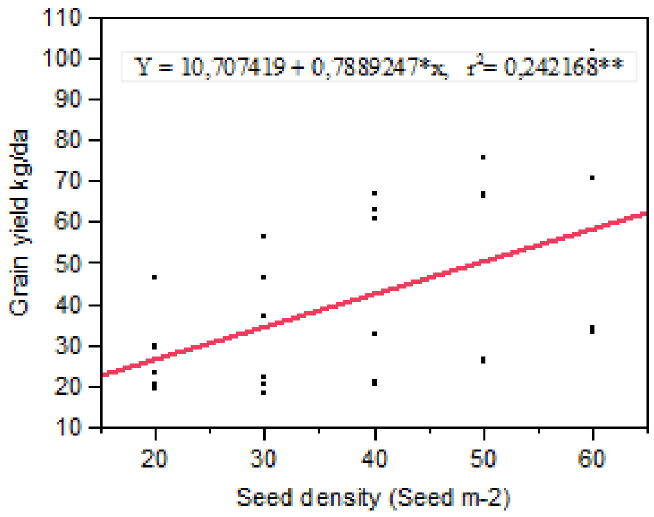

Figure 4.13. Grain yield of chickpea with different seed on densities in Bingol (Equation with slope was significant at $P < 0.01$)

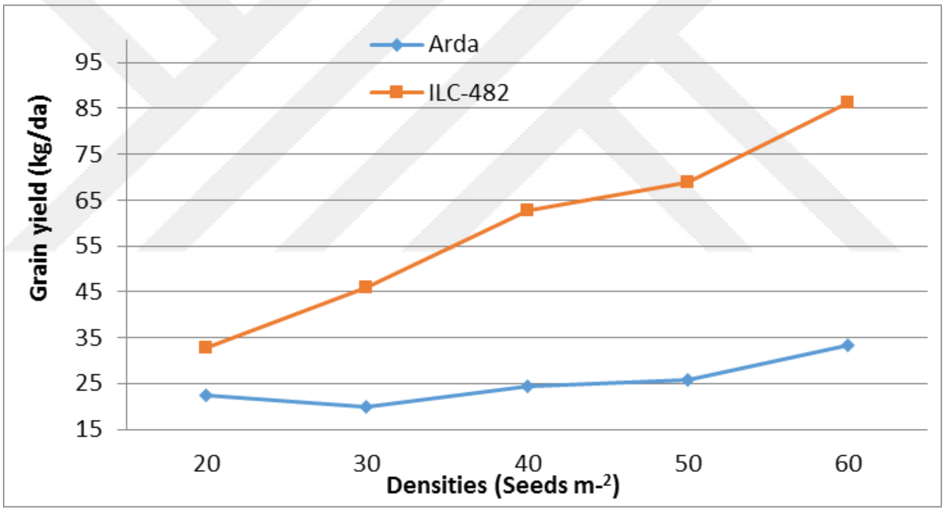

Figure 4.14. Grain yield for two chickpeas at five seeding densities

4.11. Sieves

Seed size is an important trait for trade and component of yield and adaptation in chickpea. It is one of the important works in our study and separation seeds based on size seed. Therefore, two Kabuli chickpea Turkish commercial varieties were used in the experiment. Variety Arda has large seeds, while ILC-482 has small seeds. In this study divided seeds size of chickpea to five types contained of 5 mm, 6 mm, 7 mm, 8 mm and 9 mm. This task was obtained in GAP International Agricultural Research and Education Center– Diyarbakir. (Muehlbauer et al. 1982) reported that in Kabuli types, seed shape are called ram head in Turkey, and in generally, there are three groups for seed size with large seeded (>9 mm), medium seeded (9-8 mm) and small seeded (8-7 mm) chickpeas. (Gan et al. 2003) (Biçer 2009) postulated that seed size had non- significant impact on plant growth, development and seed yield of large-seeded crops such as chickpeas.

4.11.1. Sieves (9) mm

In this study, variety and density ($P<0.05$) had significant effect while the interaction had non significant effect on sieves and seeds size. The higher number sieves 9 mm has been obtained from Arda variety (4.46%) by 40 seed m^{-2}. And the lowest number has been obtained from ILC-482 variety (0.0%) by 20, 30, 40, 50 and 60 seed m^{-2}. These results are in agreement with those obtained by (Gan et al.2003) who found that small seeds chickpea produced a smaller proportion of the 9-mm seed. This factor was affected by chickpea, genetic and environment factors (Singh 1995). On the other hand (Argikar 1956) proposed seed size to be controlled by a single recessive gene and (Ghatge 1993) proposed control by two genes. Relationship between genotype and plant density for harvest index is presented in Figure 13 and Figure 14.

Table 4.21. Sieves % 9 mm (√+1) variance analysis results of different chickpea varieties and densities

Sources	Sum Squares	Mean Squares	Degrees of Freedom	F Ratio	Prob> F
Replication	0.52757	0.26378	2	1.0000	0.5000
Variety	7.10428	7.10428	1	26.9322	0.0352*
Replication*variety &Random (Error-1)	0.52757	0.26378	2	3.1921	0.0681
Density	1.30813	0.32703	4	3.9575	0.0203*
Variety*density	13.3447	3.33617	4	2.9789	0.0514
Error-2	1.322188	0.082637	16		
C. Total	12.097870		29		<.0001
CV%	19.33674194				

*Significance at 5 % probability, **Significance at 1 % probability, ns = non-significant.

Table 4.22. Effect of varieties and seeding density on sieves % 9 mm of chickpea

	Densities (Seeds m^{-2})					**Means**
Varieties	20	30	40	50	60	
Arda	0.73(1.16)	4.46(2.27)	4.06(2.23)	3.30(1.99)	3.90(2.19)	3.29(1.97) **A**
ILC-482	0.00(1.0)	0.00(1.0)	0.00(1.0)	0.00(1.0)	0.0(1.0)	0.00 (1.00) **B**
Means	0.37(1.08) B	2,23(1.63) A	2.03(1.61) A	1.65(1.49) A	1.95(1.59)**A**	1.64
LSD variety	0.80 *					
LSD.density	0.35*					
LSD varietx density.inte	ns					

Means in columns and rows followed by the same letters are not significantly

*:√+1 transformed data in parentheses (Means in columns and rows followed by the same letters are not significantly

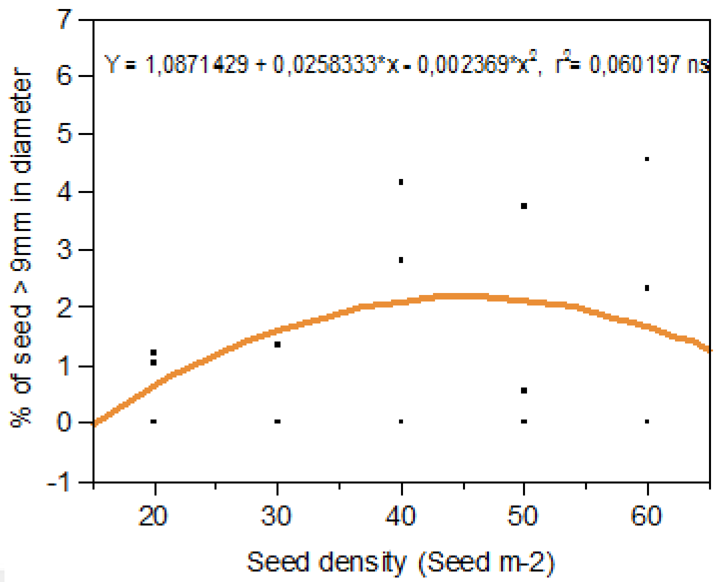

Figure 4.15. Relationship between plant seed density and the proportion of large-sized (>9–mm) seed for chickpea in Bingol (Regression equation was not significant)

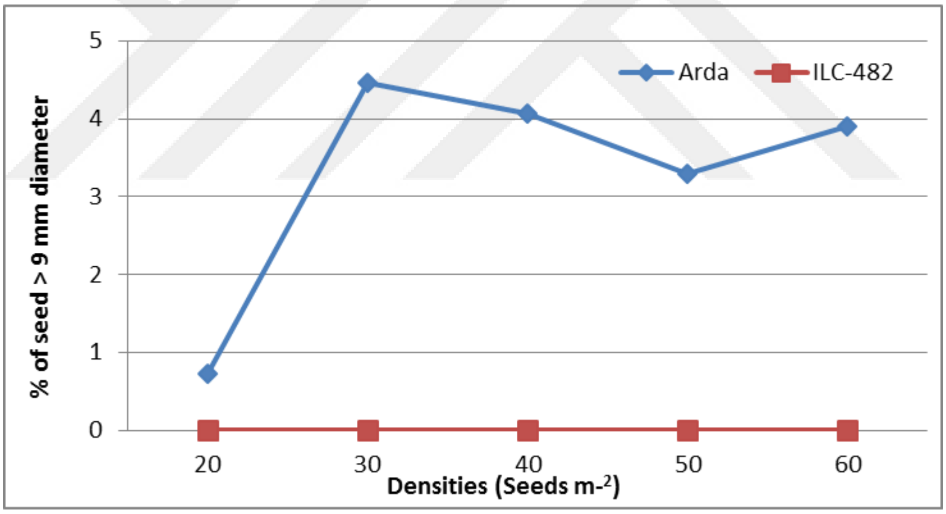

Figure 4.16. Sieve 9 mm for two chickpeas at five seeding densities

4.11.2. Sieves (8) mm

In this study, variety (P<0.05) had highly significant effect while the density and interaction had non significant effect on sieves and seeds size. Sieve number (8) mm is the second important record in this research. Table 4.23 .Table 4.24 and Figure 4.17 are showed that the number of sieves (8) mm has been obtained from Arda variety (44.36%)

by 60 seeds m^2. The lowest number of sieves (8) mm has been obtained from ILC-482 variety (16.30%) by 50 seeds m^{-2}. This research agreement with (Gan et al. 2003) reported that the different chickpea cultivars might have different plant height, seed yield components and seed size distribution, but the size of seed planted had no significant impact on most of these parameters.

Table 4.23. Sieves %8 mm variance analysis results of different chickpea varieties and densities

Sources	**Sum Squares**	**Mean Squares**	**Degrees of Freedom**	**F Ratio**	**Prob> F**
Replication	89.6327	44.8163	2	173.0360	0.0057
Variety	3783.39	3783.39	1	14607.67	<0001 **
Replication*variety&Random (Error-1)	0.518	0.259	2	0.0054	0.9946
Density	111.251	27.8128	4	0.5840	0.6787 ns
Variety*density	77.418	19.3545	4	0.4064	0.8013 ns
Error-2	761.9427	47.621	16		
C. Total	4824.1497		29		0.0003
CV%	22.16				

* Significance at 5 % probability, **Significance at 1 % probability, ns = non-significant.

Table 4.24. Effect of varieties and seeding density on sieves % 8 mm of chickpea

Varieties	**Densities** (Seeds m^{-2})					**Means**
	20	30	40	50	60	
Arda	41.43	42.86	41.53	41.63	44.36	42.36 **A**
ILC-482	24.13	16.73	18.70	16.30	23.66	19.90 **B**
Means	32.78	29.80	30.11	28.96	34.01	31.13
Variety	0.79**					
Density	ns					
Variety x density	ns					

Means in columns and rows followed by the same letters are not significantly

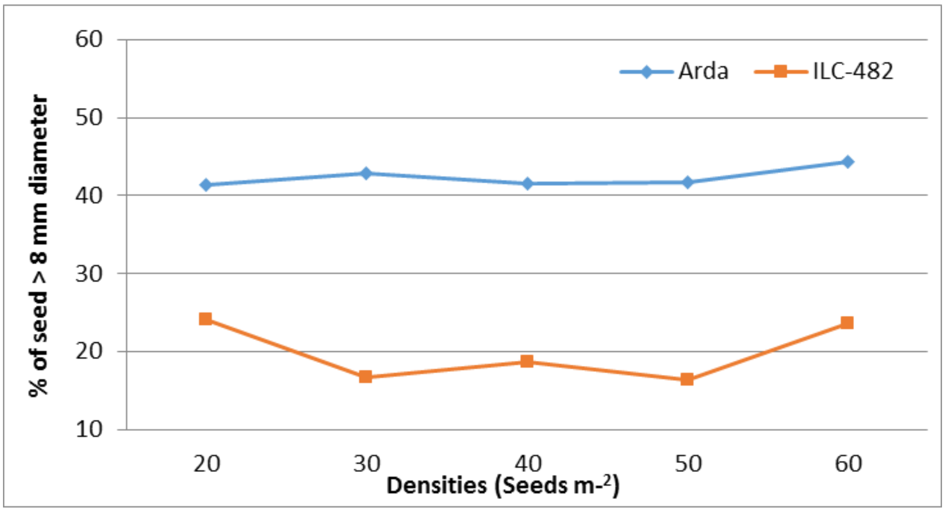

Figure 4.17. Sieve 8 mm for two chickpeas at five seeding densities

4.11.3. Sieves (7) mm

In this study, variety ($P<0.05$) had highly significant effect while the interaction and density had non -significant effect on sieves and seeds size. The sieves number (7) mm is the third stage of this works on seeds size. This study showed that there was great relationship between plant population density and the amount of large-sized (>7–mm) for chickpea. The highest number of sieves number 7 mm has been obtained from ILC-482 variety (61.43%) by 40 seed m^{-2}. On the other hand, the lowest number of sieves number (7)mm has been obtained from Arda variety (39.40 %) by 60 seed m^{-2}. (Gan et al. 2003) reported that seed size had no significant impact on plant growth, development and seed yield of large-seeded crops such as chickpeas.

Table 4.25. Sieves % 7 mm variance analysis results of different chickpea varieties and densities

Sources	**Sum Squares**	**Mean Squares**	**Degrees of Freedom**	**F Ratio**	**Prob> F**
Replication	149.786	74.893	2	3.5249	0.2210
Variety	1723.69	1723.69	1	81.1264	0.0121*
Replication*variety &Random (Error-1)	42.494	21.247	2	1.4101	0.2729
Density	103.259	25.8147	4	1.7133	0.1962
variety*density	73.3813	18.3453	4	1.2175	0.3421
Error-2	241.0800	15.068	16		
C. Total	2333.6920		29		<.0001
CV%	7.64682696				

*Significance at 5% probability, **Significance at 1% probability, ns = non-significant.

Table 4.26. Effect of varieties and seeding density on sieves %7 mm of chickpe

Varieties	**Densities** (Seeds m^{-2})					**Means**
	20	30	40	50	60	
Arda	46.16	40.90	45.33	44.00	39.40	43.16 B
ILC-482	55.26	58.86	61.43	59.70	56.33	58.32 A
Means	50.71	49.88	53.38	51.85	47.86	50.74
LSD variety	7.23 **					
LSD Density	ns					
LSD variety x density inter	ns					

Means in columns and rows followed by the same letters are not significantly

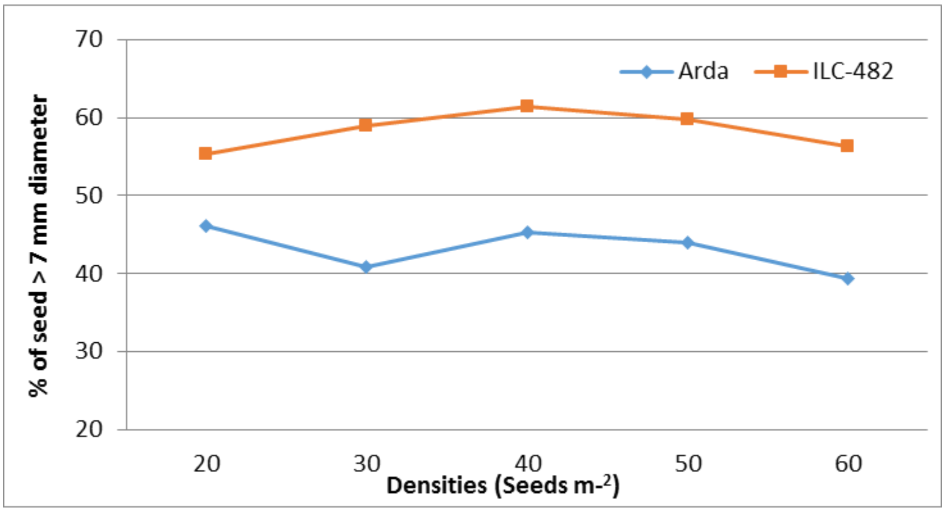

Figure 4.18. Sieve 7 mm for two chickpeas at five seeding densities

4.11.4. Sieves (6) mm

The results of the sieves 6 mm presented in Table 4.27. Table 4.28 and Figure 4.19 indicated that in this study, variety ($P<0.05$) had significant effect while the interaction and density had non- significant effect on sieves and seeds size. Sieves number (6) mm is the final part of the seeds size of this research showed that the highest number of sieves number 6 mm has been obtained from ILC-482 variety (24.36%) by 30 and 50 seed m^{-2}. The lowest number seed size 6 mm has been obtained from Arda variety, (8.56%) by 60 seed m^{-2}. (Gan et al. 2003) reported that seed size had no significant impact on plant growth, development and seed yield of large-seeded crops such as chickpeas.

Table 4.27. Sieves %6 mm variance analysis results of different chickpea varieties and densities

Sources	**Sum Squares**	**Mean Squares**	**Degrees of Freedom**	**F Ratio**	**Prob> F**
Replication	15.782	7.891	2	1.0529	0.4871
Variety	813.281	813.281	1	108.5195	0.0091
Replication*variety&Random (Error-1)	14.9887	7.49433	2	0.4843	0.6249
Density	61.6187	15.4047	4	0.9954	0.4384
Variety*density	39.2187	9.80467	4	0.6336	0.6458
Error-2	247.6027	15.4752	16		
C. Total	1192.4920		29		0.0023
CV%	23.75				

*Significance at 5% probability, **Significance at 1% probability, ns = non-significant.

Table 4.28. Effect of varieties and seeding density on sieves % 6 mm of chickpea

	Densities (Seeds m^{-2})					**Means**
Varieties	20	30	40	50	60	
Arda	11.56	12.06	12.96	11.60	8.56	11.35 B
ILC-482	20.23	24.36	19.80	24.36	20.06	21.76 A
Means	15.90	18.21	16.38	17.98	14.31	16.56
LSD variety	4.29 **					
LSD Density	ns					
LSD variety x density inter	ns					

Means in columns and rows followed by the same letters are not significantly

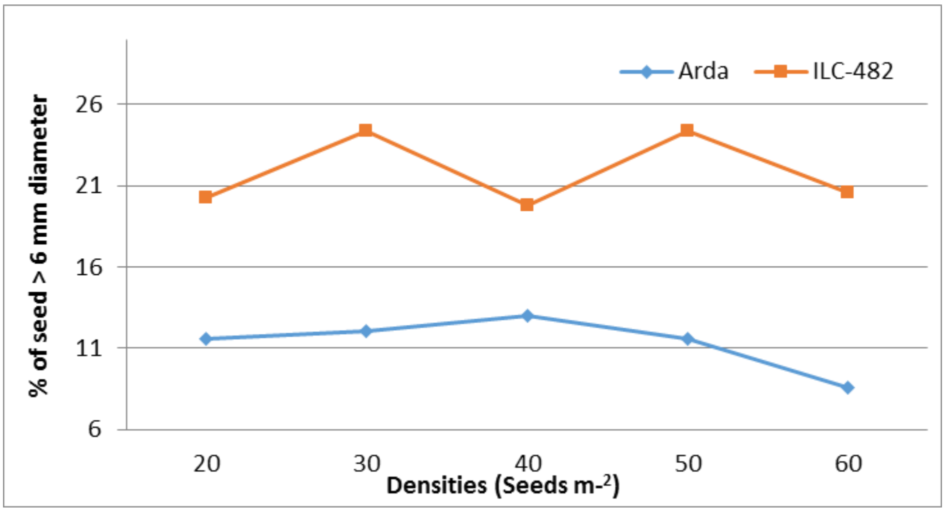

Figure 4.19. Sieve 6 mm for two chickpeas at five seeding densities

4.12. Extraction minerals seeds component

Chickpea (*Cicer arietinum* L.) belonging to the family Leguminosae, is one of the world's most important pulse crops. Chickpea seeds are nutrient-dense foods providing rich content of protein and certain dietary minerals such as iron and phosphorus, thiamin, vitamin B6, magnesium and zinc contents are also present in (Khatoon and Prakash 2004). The chickpea is a good source of protein and carbohydrate and its protein quality is better than other legumes such as pigeon pea, black gram and green gram. It also supply some minerals (Ca, Mg, Zn, K, Fe, P) and vitamins like thiamine and niacin (Vilche et al. 2003). In our study it was researched and foundation percentage of (ppm) some metal such as (Fe, Ni, Na and Zn).

4.12.1. Iron (Fe)

Table 4.29. Fe element contain in sample seed variance analysis results of different chickpea varietie

Sources	Sum Squares	Mean Squares	Degrees of Freedom	F Ratio	Prob> F
Replication	9.3945	4.69725	2	0.683	0.5944
Variety	25.5948	25.5948	1	3.710	0.1936
Replication*variety Random(Error-1)	13.7682	6.88409	2	2.690	0.0977
Density	9.83464	2.45866	4	0.9640	0.4539
Variety*density	5.81525	1.45381	4	0.5700	0.6882
Error-2	40.80898	2.55056	16		
C. Total	105.21637		29		0.1044
CV%	31.21				

*Significance at 5 % probability, **Significance at 1 % probability, ns = non-significant.

In this study, variety, density and interaction ($P<0.05$) had non- significant effect on Fe element. The summerised Fe values are showed in Table 4.29 .Table 4.30. It was observed that the concentration and peak intensity value of iron (Fe) element. The highest value has been obtained from ILC-482 (6.53 ppm) by 60 seed m^{-2}. The lowest value of Fe has been obtained from Arda variety (3.14 ppm) by40 seed m^{-2}.(Haytowitz and Matthews 1983) reported that cooking in boiling water caused great losses of K (24%) Cu (15%) and Fe (8%).

Table 4.30. Effect of varieties and seeding density on mineral Fe (ppm)of chickpea

	Densities (Seeds m^{-2})					**Means**
Varieties	20	30	40	50	60	
Arda	3.73	3.78	3.14	5.99	4.31	4.19
ILC-482	5.82	5.62	6.00	6.20	6.53	6.03
Means	4.77	4.70	4.57	6.09	5.42	5.11
LSD variety	ns					
LSD Density	ns					
LSD variety x density inter.	ns					

Means in columns and rows followed by the same letters are not significantly

4.12.2. Nickel (Ni)

The results of the Ni element are presented in Table 4.31 and Table 4.32. The main effect of variety was significant ($P<0.05$) but density and interaction had non-significant. In our study was worked in laboratory center in Bingol university to finding overage of Ni element contain. The highest value has been obtained from ILC-482 (6.73 ppm) by 50 seed m^2. The lowest number has been obtained from Arda variety with (5.85 ppm) by 40 seed m^2. (Ali et al. 2002). Micronutrient availability for the plant depends, among other factors texture organic matter and mainly soil.

Table 4.31. Ni element contain in sample seed variance analysis results of different

Sources	**Sum Squares**	**Mean Squares**	**Degrees Freedom**	**of F Ratio**	**Prob> F**
Variety	0.2512	0.1256	2	27.5898	0.0350
Replication*variety Random(Error-1)	1.61472	1.61472	1	354.6886	0.0028*
Density	0.00911	0.00455	2	0.0508	0.9506
Variety*density	0.30137	0.07534	4	0.8403	0.5196
Error-2	0.39789	0.09947	4	1.1094	0.3862
C. Total	1.4346400	0.089665	**16**		
CV%	4.0089300		29		0.0676
	4.65				

*Significance at 5 % probability, **Significance at 1 % probability, ns = non-significant.

Table 4.32. Effect of varieties and seeding density on mineral Ni (ppm)of chickpea

	Densities (Seeds m^{-2})					**Means**
Varieties	20	30	40	50	60	
Arda	6.30	6.21	5.85	6.1 5	6.48	6.19 B
ILC-482	6.56	6.63	6.69	6.73	6.69	6.66 A
Means	6.43	6.42	6.27	6.44	6.59	6.42
LSD variety	0.1*					
LSD Density	Ns					
LSD variety x density inter.	Ns					

Means in columns and rows followed by the same letters are not significantly

4.12.3. Sodium (Na)

The results of the Na element are presented in Table 35 and Table 36. The main effect of variety, density and interaction had non-significant effect by (P<0.05). The highest Na value of chickpea has been obtained from ILC-482 variety (5.03 ppm) in 30 seed m-^{2}. While, the lowest value of Na has been obtained from Arda variety (3.67 ppm) by 20 seed m^{2}. (Ali et al. 2002). Micronutrient availability for the plant depends, among other factors texture organic matter and mainly, soil pH. Micronutrient availability for the plant depends, among other factors, texture, organic matter and mainly oil pH.

Table 4.33. Na element contain in sample seed variance analysis results of different chickpea varieties

Sources	Sum Squares	Mean Squares	Degrees of Freedom	F Ratio	Prob> F
Replication	3.20636	1.60318	2	0.3525	0.7394
Variety	2.56669	2.56669	1	0.5644	0.5309
Replication*variety Random(Error-1)	9.0959	4.54795	2	2.5157	0.1122
Density	1.52576	0.38144	4	0.2110	0.9285
Variety*density	2.32378	0.58095	4	0.3213	0.8595
Error-2	28.925343	1.80783	16		
C. Total	47.643834		29		0.6566
CV%	30.98				

*Significance at 5 % probability, **Significance at 1 % probability, ns = non-significant.

Table 4.34. Effect of varieties and seeding density on mineral Na (ppm) of chickpea

Varieties	**Densities** (Seeds m^{-2})					Means
	20	30	40	50	60	
Arda	3.67	3.7 8	3.85	4.25	4.67	4.04
ILC-482	4.73	5.03	4.10	4.89	4.38	4.62
Means	4.20	4.40	3.96	4.57	4.53	4.33
LSD variety	ns					
LSD Density	ns					
LSD variety x density inter.	ns					

Means in columns and rows followed by the same letters are not significantly

4.12.4. Zinc (Zn)

The results of variance analysis of Zn element value of different sample chickpea seed varieties are given in Table 37. Table 38 below. The main effects of variety and the interaction effects of variety x density had non-significant influence on the Zn element. Table suggests that the highest average of Zn has been obtained ILC-482 variety (4.30

ppm) by 20 seed m-^{2}. Whereas the lowest value was obtained Arda verity (1.91 ppm) by 40 seed m-^{2}. Zn plays an important role in plant reproductive development for initiation of flowering, floral development, male and female gamete genesis, fertilization and seed development (Liu et al. 2005).(Khan 1998).(Ahlawat et al. 2007). A comparison between several crop species has shown that chickpea is more sensitive to Zn deficiency than cereal and oil seeds.

Table 4.35. Zn element contain in sample seed variance analysis results of different chickpea

Sources	Sum Squares	Mean Squares	Degrees of Freedom	F Ratio	Prob>F
Replication	1.6102	0.8051	2	0.5840	0.6313
Variety	2.09881	2.09881	1	1.5225	0.3426
Replication*variety Random(Error-1)	2.75704	1.37852	2	2.4122	0.1214
Density	2.94157	0.73539	4	1.2868	0.3165
variety*density	7.10554	1.77638	4	3.1084	0.0452*
Error-2	9.143580	0.57147	16		
C. Total	25.656734		29		0.0660
CV%	21.55				

* Significance at 5 % probability, **Significance at 1 % probability, ns = non-significant.

Table 4.36. Effect of varieties and seeding density on mineral Zn (ppm) of chickpea

Varieties	**Densities** (Seeds m^{-2})					**Means**
	20	30	40	50	60	
Arda	3.57a	3.56ab	1.9ab	3.32ab	3.84ab	3.24
ILC-482	4.30ab	3.17ab	4.08ab	3.98ab	3.30ab	3.76
Means	3.94	3.37	2.99	3.65	3.57	3.5
LSD variety	ns					
LSD Density	ns					
LSD variety x density inter.	1.30*					

Means in columns and rows followed by the same letters are not significantl

5. SUMMARY AND CONCLUSIONS

As one of the oldest groups of agricultural plants, food legumes are the second most important human's food supply after the cereal grains, which their grain contain 38 to 59 % carbohydrate, 4.8 to 5.9% oil, 3% ash, 3% fiber, 0.2% calcium, and 0.3 phosphorus (Hulse 1991). Chickpea *(Cicer arietinum* L.) is an annual grain legume or pulse' crop sold into human food markets. Chickpea is the third most important food legume crop and India is the largest producer contributing to 65% of world's chickpea production (Faostat 2012). Chickpea (*Cicer arietinum* L.) is one of the most important world legume crops and is a food legumes for about third of the world's population.

In Turkey, it is one of the major legumes grown farmers under dry conditions. It is one of the crops produced in Middle and South Eastern Anatolia where its production and yield is low due to the agronomic unconsciousness, in appropriate seed density and unavailability of adaptable cultivars. This indicates that the need to conduct research and determine the optimal seed density and adaptable caltivars in growing area as one of important agronomic managements to improve production and yield of chickpea. Therefore, the study was conducted at field experimental area of Bingol University, Turkey with the objectives of evaluating the effect of seed density, varieties and interaction on yield and yield related traits and to determine seed of different seed density and its associations with yield and yield components of chickpea varieties.

The study consisted of laboratory and field experiment of which laboratory experiment was conducted at Bingol University scientific institute and Field Crops Laboratory to determine the seed micro element of Fe. Ni. Na and Zn.

The experiment was carried out in split block design with three replications at Bingol (38o 48 N latitude and 40o 32 E longitude), Turkey. Two factorial trial was set up as a split-plot design (RCBD) with comparing two chickpea varieties (Arda and ILC-482) as main plots and five seed densities (20, 30, 40, 50 and 60 seed m^2) as split-plots. Seeds of varieties (Arda And ILC-482) obtained from GAP International Research and Training Center Diyarbakır, Turkey.

The main effect of variety (Arda and ILC-482) was significant effect on emergence rate, days to flowering, first pod height, grain yield, harvest index, sieves 9 and sieves 8, Fe and Ni. Besides, the main effect of densities (20. 30. 40. 50 and 60 seed m^2) were significant effect on emergence rate, days to flowering, biological yield, number pods per plant, grain yield and sieves 9. The results showed that the interaction of seed density and variety had significant ($P<0.05$) effect on grain yield and microelement of Zn.

The study showed that plant density related to seed yield and the biggest number of pods per plant usually obtained at low density due to decreased number of pods per plant. As a result, number pods per plant was inversely related to plant density. The yield components such as both pods number per plant and biological yield were significantly affected by only seed density. Also, the highest thousandgrain weight has been obtained from Arda variety by (316.66 g) in 60 seed m^2. The lowest thousand grain weight has been obtained from ILC-482 variety (256.66 g) by 30 seed m^2. The biggest seeds weight were produced by plants at the lowest densities and the smallest seeds weight at the highest densities. This can be explained by increased competition among plants. However, (Zahoor 1991) reported that thousand grain weight, biological yield, seed yield and harvest index were not significantly influenced by different seeding densities of chickpea. In this study, the variety and seed density had significant ($P < 0.05$) effect on grain yield. Variety ILC-482 produced the maximum grain yield (86.26 kg/ da) by 60 seed m-2and Arda gave the lowest grain yield (19.80 kg/ da) by 30 seeds m^2. The higher grain yield in ILC-482 was attained due to more number of pods per plant, thousand grain weight, brunch number and harvest index as compared to Arda, respectively. This showed the possible of increasing the yields of the two varieties in the study area using appropriate seed density.

Although the final study was analyzed seed sieves has been depended on seed size and the minerals analysis of Fe. Ni. Na and Zn to determine the (ppm) percentage value of sample seeds of chickpea and separation seed chickpea was depending on seeds size. In both types (sieves and minerals analyze) was significant effect on variety but non-significant effect on density and interaction, except Zn. These results suggested that the importance of using appropriate seed density and variety to increase yield of chickpea in the study area.

Over all, this overview, based on one season at one location, requires evidence with further studies to give a valid recommendation. So, to increase the yield of chickpea, future research directions have to be focused on verifying the present investigation across years and locations for reach at a eventual suggestion on plant density by taking the financial aspects, chickpeas, point planting and more varieties.

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