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Effect of Variety and Sowıng Density on Some Mıcroelements Content and Grain Yield of Chickpea (*Cicerarietinum* L.)

Hasan KILIÇ[1*], Mohammed Hussein AZIZ[2]

[1]. Bingol university Faculty of Agriculture Fielad crops Department, Bingöl, Turkey
[2]. Predatory School of Education Ministry,Halebja, Iraq

Abstract— *The objective of this study was to determine the effects of cultivars in different sowing densities on microelementsiron (Fe), nicel (Ni),zinc (Zn)and sodıım (Na) and grain yield of chickpea (Cicerarietinum L). Field experiment was performedin research farm at the University of Bingol(Turkey) in 2016. A complete blocks design in 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 results indicated that seeding densities significantly affected grain yield and Ni content while Fe, Ni and Zn were not affected significantly.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 highest Ni conten has been obtained from ILC482 variety (6.66 ppm) andthe lowest Ni content has been obtained from Arda variety (6.20 ppm).*

Keywords—Chickpea, microelements, seeding density, variety.

I. INTRODUCTION

Chickpea (*Cicerarietinum 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). According to Akhtarand Siddiqui (2009) during last decade the production of chickpea have declined. 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. In Turkey, it occupies about 388.518 hectare area with production of 450.000 tonnes and an average productivity of 1158.2 kg ha^{-1} (TUIK 2014). Inspite of the importance of this crop in human daily diet and in agricultural production, productivity of thiscrop is low in Turkey.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, 4.8 to 5.9% oil, 3% ash, 3% fiber, 0.2% calcium, and 0.3% phosphorus. In general, pulsecropscontain a range of nutrients including low digestible carbohydrates, protein, essential amino acids, fattyacids, and a range of micronutrients (Bhatty, 1988). Bueckert et al (2011) reported that chickpea seeds contained from 29 to 52 mg/kg Zn, 77–112 mg/kg Fe, 1,448–2,457 mg/kg Mg, 1,211–2,457 mg/kg Ca, to 3.8–9.0 mg/g phyticasid. Cereals like wheat and rice combined with pulses are major dietary components for billions of people, and the potential for microelemetbiofortifcation of pulses is high. Chickpea is an important source of microelements like Fe, Zn, Mg, and Ca in vegetarian diets (Abbo et al., 2000; Ereifej et al., 2001).Whereas, limitedinformation is available on chickpea (*Cicerarietinum* L.) mineral biofortification.Micronutrient concentrations in the pulse lentil may vary depending on the geographical location, plant genotype, soil factors, temperature, and other growing season conditions (Thavarajah et al., 2010; Bueckert et al., 2011).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 (Turneret 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. The objectives of this study were to determine the effect of plant density and varieties on grain yield and some microelemntscharacteristics of chickpea under agro-climatic conditions of Bingol, Turkey.

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II. MATERIALS AND METHODS

The present study was conducted throughout spring season in 2016 at the research experiment field of the Bingol University (Turkey) located at 38° 48 N latitude and 40° 32 E longitude (10 km South Bingol) and at an altitude of 1090 m. Experimental field location receives annual rainfall of 938 mm. During the study in 2016, the lowest minimum temperature was fell down below to -5.6°C in January. 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 98.4 mm (Figure 1, Figure 2 andFigure 3).The soil of experiment field is loamy, with contents of organic matter of around 1.9% and pH 6.57. Microelement values were taken from Demir (2016). The soil analysis result for physical and chemical characteristic of the study area are given in Table 1.

Table.1: Soil analysis result for physical and chemical characteristic of the study area

Soildepth	Soiltexture	pH	Salt Content	OrganicMatter	P_2O_5	K_2O	Lime	Fe	Zn	Na
Cm			%	%	Kg/ha		%	ppm		
0-30	Loam	6.57	0.0315	1.905	7.91	24.51	0.36	14.15	0.33	0.78

Two registired cultivars kabuli type(Arda and ILC-482) , adapted to South Easten AnatoliaTurkey were chosen with a morphologicaltraits (Table 2). The seeds were drilled 5-8 cm deep in previously opened furrows on 05th April 2016. In this study,thewholedose of P (6 kg P da^{-1}) withhalf of dose of nitrogen (5 kg N da^{-1}) wereapplied at sowing time and there maining nitrogen (5 kg N da^{-1}) was top-dressed as Ammoniumnitrate (%33) with flowering time on 26 July.2016. Rhizobium bacteria nodules were not observed in the roots of chickpea parsels.Weeds were controlled by hand after germination.

Table.2: Name andgeographicalorigins of investigatedcultivars

Cultivar	Plant height cm	Firstpodheight cm	100 kernelweight g.	Plant type	Origin
Arda	64-85	33-37	34-40	Erect	GAPUTAEM
ILC-482	40-45	20-26	28-31	Semi-prostrate	GAPUTAEM

Experimental design and management: Two factorial trial was set up as a split-plot design (RCBD) with two comparing chickpea varieties (Arda and ILC-482) as main plots and fiwe seed densities (20, 30, 40, 50 and 60 seed m^{-2}) as split-plots. The main plots were randomised in a block design with three repilications. The density treatments were randomised in the main 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

Microelemnts analysis: Fe, Ni, Znand Nacompositions of whole chickpea flour were determined by the method of Hwang et al.(1997) and; 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 5ml of distilled water slowly and completed to 25ml 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)

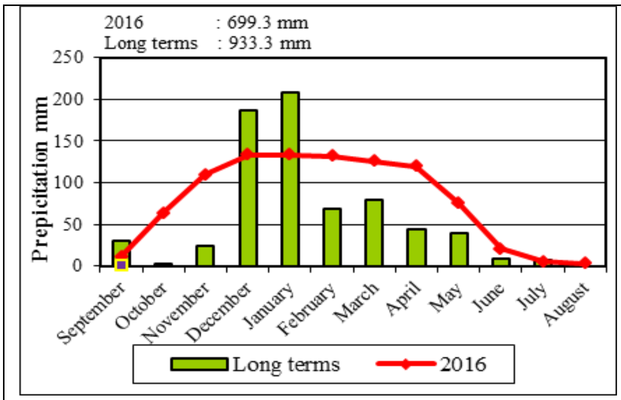

Fig.1: Total prepicitatiom(mm) in the growing

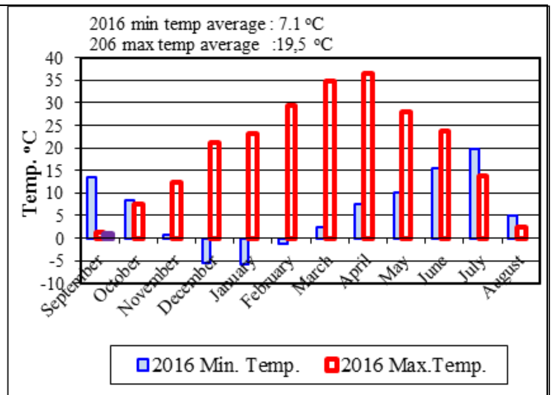

Fig.2: Max and Min temperatures (°C) in the

environment		growing environment

Statistical Data Analysis: Results were evaluated to analysis of variance SAS (Statistical Analysis Systems) program (SAS Institute 1999) and mean separation was performed by Fisher's least significant difference (LSD) test when F test was significant at P<0.05.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.

III. RESULTS AND DISCUSSION

Table.3: Analysis of variance of grain yield (kg/da) of different chickpea varieties and densities.

Sources	DF	Mean Squares				
		Grain yield	**Fe**	**Ni**	**Zn**	**Na**
Replication	2	15.2629	4,6972	0,1256	0,8051	1,6032
Variety	1	8768 *	25,5948 ns	1,6147*	2,0981ns	2,5667 ns
Replication*variety&Random(Error1	2	90.035	6,8840	0,0045	1,3785	4,54870
Density	4	958.483**	2,4586 ns	0,0753 ns	0,7354ns	0,3814 ns
Variety*density	4	407.078**	1,4538 ns	0,0994 ns	1,7764*	0,5810 ns
Error-2	16	61.24	2,5505	0,0896	0,5715	1,8078

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

Grain yield (kg/da): Table 3 and Table 4 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 seed/m^{-2} and Arda gave the lowest grain yield (19,80 kg/da) by 30 see/m^{-2}. 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 by regression equation in Figure 4 and Figure 5. These results were 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. Regression analysis revealed that the grain yield increased linearly (R^2 = 0.48, 0.82) with seed rate for Arda and ILC-482 (Figure 4 and Figure 5).

Table.4: Effect of plantingdensityandvariety on thegrainyield, Fe, Ni, ZnandNacontents of chickpea

Traits	Cultivars	Densities(Seeds m^{-2})					Means
		20	30	40	50	60	
Grain yield kg/da	Arda	22.48 de	19,80e	24,43de	25,69de	33,41cd	**25,16B**
	ILC-482	32.71cde	46,02c	62,86b	68,93b	86,26 a	**59,36A**
Means	**27.59 C**	**32.91 C**	**43.64 B**	**47.31 B**	**47,31B**	**59,84A**	
Fe (ppm)	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**	
Ni (ppm)	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**	
Zn (ppm)	Arda	3,57 ab	3,56 ab	1,91 b	3,32 ab	3,84 ab	**3.24**
	ILC-482	4,30 a	3,17 ab	4,08 ab	3,98 ab	3,30 ab	**3.76**
Means		**3.94**	**3.37**	**2.99**	**3.65**	**3.57**	
Na (ppm)	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**	

*:Means within columns or rows with the same letters are not significantly different at 5% level.

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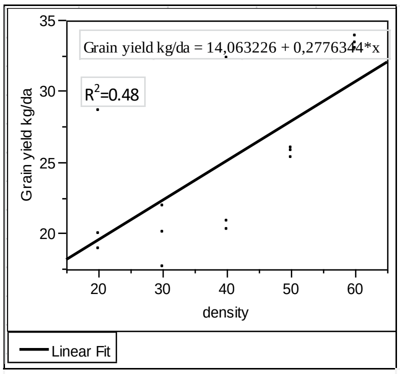

Fig.4: Regression of grain yield of variety Arda with different seed on densities

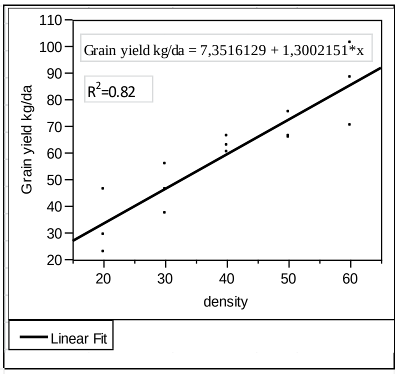

Fig.5: Regression of grain yield of variety ILC-482 with different seed on densities

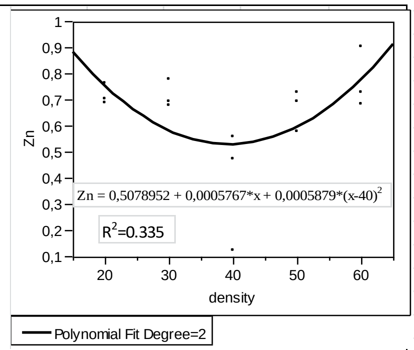

Fig.6: Regression of Zn content of variety Arda with different seed on densities

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Extraction minerals seeds component: Chickpea (*Cicerarietinum* 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 researched and foundation percentage of (ppm) some metal such as (Fe, Ni, Na and Zn).

Iron (Fe): In this study, variety, density and interaction ($P<0.05$) had non significant effect on Fe elemen. The summerised Fe values are showed in Table 3 and Table 4.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 lossesof K (24%), Cu (15%) and Fe (8%).According to regression analyses, there was neither linear nor quadratic relationship between fe content and seed rate for both cultivars.

Nicel (Ni): The results of the (Ni) element are presented in Table 3 and Table 4. The main effect of variety was significant ($P<0.05$) but density and interaction had non significant. In our study was working 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 $m\text{-}^{2.}$ The lowest number has been obtained from Arda variety was (5.85 ppm) by 40 seed $m\text{-}^{2}$.Micronutrient availabilityfor the plant depends, among other factors, texture organic matter and mainly soil(Ali et al., 2002). According to regression analyses, there was neither linear nor quadratic relationship between Fe content and seed rate for both cultivars.

Zinc (Zn): The results of variance analysis of Zn element value of different sample chickpea seed varieties are givenin Table 3 and Table 4. The main effects of variety and the interaction effects of variety x density had non-significant influence on the Zn element. Table 39 and Table 40 suggests that the highest average of Zn has been obtained ILC-482 variety (4.30 ppm) by 20 seed $m\text{-}^{2}$. Wherease, the lowest value was obtained Arda verity (1.91 ppm) by 40 seed $m\text{-}^{2}$. 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; Ahlawatet al.,2007). A comparisonbetween several crop species has shown that chickpeais more sensitive to Zn deficiency than cereal and oil seeds.Arda showed a quadratic trend ($R^2 = 0.335$) for Zn content for the different seeding rates. while regression equation was not significant in ILC-482 (Figure 6)

Sodium (Na): The results of the Na element are presented in Table 3 and Table 4. The main effect of variety, density and interaction had nonsignificanteffct by ($P<0.05$). The highest Na value of chickpea has been obtained from ILC-482 variety (5.03 ppm) in 30 seed $m\text{-}^{2}$. While, the lowest value of Na has been obtained from Arda variety (3.67 ppm) by 20 seed $m\text{-}^{2}$.(Ali et al., 2002). Micronutrient availabilityfor 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 mainaly soil pH. According to regression analyses, there was neither linear nor quadratic relationship between fe content and seed rate for both cultivars.

IV. CONCLUSION

Theresults of thisresearchshowedthatmaximumyield of grainwasobservedwithILC-482 relatedto 60 seed/m^{-2} density.The main effects of variety and the density had nonsignificant influence on the Fe, Zn and Na elements, except Ni. However, density x variety interaction was significant only in Zn element.

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