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Full Length Research Paper

Botanical characteristics of chickpea genotypes (*Cicer arietinum* L.) under different plant densities in organic farming

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This study was performed in Nurdagi district of Gaziantep Province of Turkey in 2011 growing season. Inci and 55-C chickpea (*Cicer arietinum* L.) genotypes were sowed at 30, 40, 50 and 60 plant m^{-1} plant densities and the effects of sowing densities on plant botanical characteristics were investigated. In the research, plant height, first pod height, number of first branch, number of second branch and stem diameter varied between 38.33 to 47.73 cm, 23.87 to 34.27 cm, 2.07 to 2.80 number $plant^{-1}$, 0.73 to 2.03 number $plant^{-1}$ and 451 to 584 µm, respectively. Results showed that plant densities in the measured parameters are significantly different, except the number of the second branch. On the other hand, results of experiment revealed that genotypes were significantly differed in plant height and stem diameter while no significant differences were determined in the other parameters measured (P < 0.05).

Key words: Chickpea (*Cicer arietinum*), plant density, yield, botanical characters.

INTRODUCTION

There are about 60 domesticated grain legume species in the world (Hedley, 2001). The Chickpea (*Cicer arietinum* L.) is fifth most important legume in the world, on the basis of total production after soybean, groundnuts, beans and peas (Muzquiz and Wood, 2007). It is an important source of protein, carbohydrate, B-group vitamins, and certain minerals (Williams and Singh, 1988), particularly to the populations of developing nations (Chavan et al., 1987). It is an important source of cheap protein with high energy and nutritive value (Hulse, 1991; El-Karamany and Bahr, 1999).

Chickpea is largely cultivated in the temperate region (Joshi et al., 2001). 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, 1976; Berger and Turner, 2007).

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. The amount of chickpea production in Turkey was 562.564 tons, harvest area and yield was respectively 454.928 ha and 1236.6 kg/ha (Anonymous, 2011a). Legumes grown in rotation with the other plants are the great source of nitrogen. Molecular nitrogen (N2) forms about 78% of the atmosphere by volume (Krzyzanowski, 2010). Chickpea is a crop that fixes nitrogen from atmosphere. With the harvest of such grain legumes the soil N fertility is generally depleted and the following crops do not get any benefit (Fatima et al., 2008; Krouma, 2009). Aslam et al. (1997) observed 74 kg ha^{-1} total nitrogen fixed. For this reason, it does an important role in organic farming systems.

Plant density is very important to facilitate aeration and light penetration into plant canopy for optimizing rate of photosynthesis (Khan et al., 2010; Azizi and Kahrizi, 2008; Kahrizi et al., 2011). On the other, population density is also economically important, owing to seed costs (Martin et al., 1994). Beech et al. (1989) concluded that the number of plants per unit area influences plant size and yield components. Abbas (1990), Sarwar (1998) and Shamsi (2009) reported that the numbers of branches $plant^{-1}$ were significantly affected by different plant density. Shamsi (2009) reported that plant and first pod height were significantly affected by variety and density. Felton et al. (1996) concluded that plant height

was higher in higher plant populations (60 plant m^{-2}). Regan et al. (2003) concluded that optimum plant population density from 40 to 45 plants m^{-2} for Kabuli types and from 45 to 50 plants m^{-2} for desi types. Abbas (1990) and Sharar et al. (2001) stated that the numbers of branches $plant^{-1}$ were significantly affected by different seed rates. This study was aimed to determine the botanical characteristics of chickpea genotypes (*C. arietinum* L.) under different plant densities in organic farming.

MATERIALS AND METHODS

Site description

A field investigation was carried out to determine the response of chickpea genotypes in terms of plant botanical characteristics to different plant densities in organic farming. Experiment was conducted under irrigated conditions in 2011. Two genotypes (Inci cultivar and 55-C line) of chickpea (*C. arietinum* L.) were grown at 30, 40, 50 and 60 plant m^{-1} plant densities in Gaziantep/Nurdagi (Longitude: 36° 43' 0" E, Latitude: 37° 11' 0" N, Elevation: 486 m). Soil characteristics of the research area in Table 1 and some climatic features in Table 2 were given (Anonymous, 2011b).

Experiment

The field experiment was laid out in a randomized complete block design (RCBD) with 3 replications. All entries were planted in late March 2011. Individual plot size was 2 × 5 m = 10 m^2. The experiments were maintained in accordance with the recommended organic cultural practices.

Measurements

Observations plant height (cm), first pod height (cm), number of first branch (number $plant^{-1}$), number of second branch (number $plant^{-1}$) and stem diameter (µm) were randomly taken from five plants (Adhikari and Pandey, 1982; Anonymous, 1985; Colkesen and Cokkizgin, 2007). The diameters of the stems were measured using a micrometer caliper.

Statistical analysis

Results were evaluated to analysis of variance using the Statistical Analysis System (SAS 9.0) software (SAS, 2004) and mean separation was performed by Fisher's least significant difference (LSD) test when F test was significant at $P < 0.05$ (Duzgunes et al., 1987).

RESULTS AND DISCUSSION

Plant height (cm)

Plant height was significantly affected by plant density and genotypes (Table 3). Maximum plant height (46.10 cm) was recorded in 50 plant m^{-2}, which was followed by 60 plant m^{-2} density with 45.50 cm while the lowest plant height (40.60 cm) were recorded in 30 and 40 plant m^{-2} densities. In the study, plant height was taller in higher plant population treatments due to more competition for light. Similar observations had been made by Jasinska and Kotecki (1995) and Felton et al. (1996), Khan et al. (2001) and Sharar et al. (2001) observed plant height increase with high densities. On the other hand, 55-c genotype plant height (44.63 cm) was significantly different from Inci cultivar plant height (41.77 cm). Plant height could be different between species and different varieties. Our findings are similar to Parvez et al. (1989). Relationship between genotype and plant density for plant height is presented in Figure 1.

First branch number

First branch number was affected significantly by different plant density but differences between genotypes were no significant. First branch number increased when the plant density decreased. The highest value, that is 2.75 number $plant^{-1}$, was observed in 30 plants per m^2. Singh et al. (1979), Singh et al. (1988), Hintz et al. (1992), Togay et al. (2005) and Bakry et al. (2011) reported that the number of branches decreased with the increase in density.

No significant differences between genotypes for first branch number. Shamsi et al. (2011) stated that the number of branches was not affected by cultivar. Figure 2 shows the relationship between genotype and plant density for first branch number.

Second branch number

No-significant differences were determined between genotypes and plant population treatments. But considerably decrease was observed in second branch number, depending on population of plant in all genotypes which used. These results are in agreement with those obtained by Togay and Togay (2001) and Cokkizgin (2007). Relationship between genotype and plant density for plant height is presented in Figure 3.

First pod height (cm)

The highest first pod height was obtained from 60 plant per m^2 (33.00 cm), whereas the lowest was 40 and 30 plant per m^2 (24.70 and 26.30 cm respectively). The first pod height was decrease when the plant density decreased, which shows that first pod height parallel with plant height. Adhikari and Pandey (1982) and Ozgun et al. (2004), reported same results. Vanderpuye (2010) reported that lowest pod height increased significantly with increasing PPD (Plant Population Density). On the other hand, no significant difference between 55-c and Inci genotypes. Figure 4 shows the relationship between genotype and plant density for first pod height.

Table 1. Soil characteristics of the field area for 2011 year.

Soil texture	pH	Organic matter (%)	Salinity (%)	Lime (%)	Total P (ppm)	Total K (ppm)	Total Fe (ppm)	Total Cu (ppm)	Total Zn (ppm)	Total Mn (ppm)
Clay-loam	8.03	4.25	0.055	14.3	1.85	425	0.24	0.31	0.43	1.07

Table 2. The average rainfall and temperature records in Gaziantep conditions for many years (1975-2010).

Months	Average temperature (°C)	Average high temperature (°C)	Average low temperature (°C)	Average sunshine hours	Average number of rainy days	The average amount of rain (kg/m^2)
March	8.4	14.3	3.2	5.5	12.3	74.5
April	13.3	19.8	7.5	6.9	10.9	56.1
May	18.7	25.7	12	8.7	6.8	29.3
June	24.1	31.4	17.1	10.6	2.7	7.9
July	27.8	35.5	21	10.8	1.8	6.3
Average	18.5	25.3	12.2	8.5	6.9	
Total						174.1

Table 3. Effect of plant densities and genotypes on all measured parameters.

Plant per m^2	Plant height (cm)	First branch number (number plant^{-1})	Second branch number (number plant^{-1})	First pod height (cm)	Stem diameter (µm)
30	40.60 B	2.75 A	2.02	26.30 B	574 A
40	40.60 B	2.40 AB	1.63	24.70 B	545 A
50	46.10 A	2.43 AB	1.43	30.70 A	532 AB
60	45.50 A	2.17 B	0.97	33.00 A	486 B
Lsd	3.91	0.38	0.74	4.34	45.60
SD					
Genotypes					
55-c	44.63 A	2.47	1.77	29.00	555 A
Inci	41.77 B	2.41	1.26	28.30	513 B
Lsd	2.76	0.27	0.53	3.07	32.20
Mean	43.20	2.44	1.51	28.65	534.20

Values with different letters show significant effect ($P<0.05$).

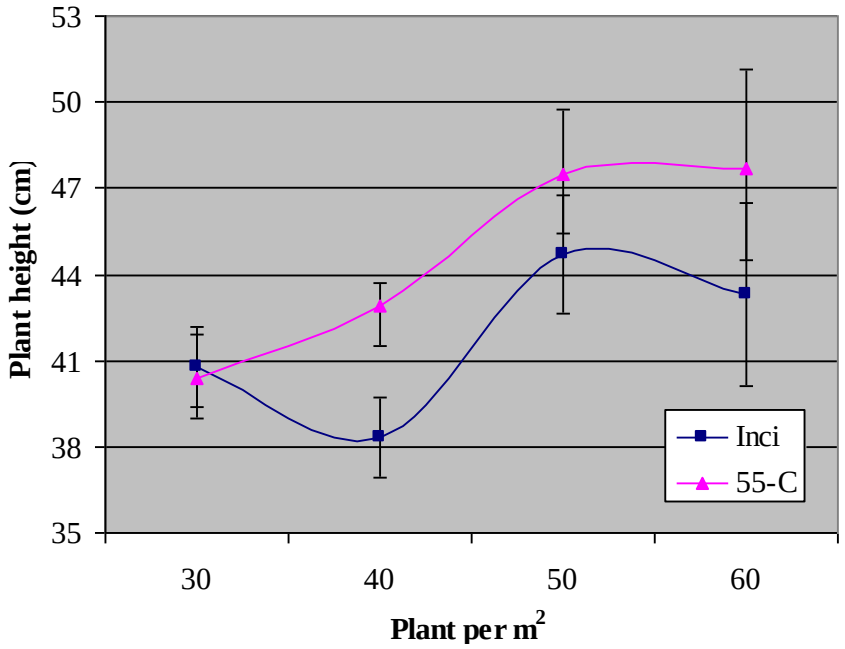

Figure 1. Relationship between genotype and plant density for plant height in chickpea (*Cicer arietinum* L.)

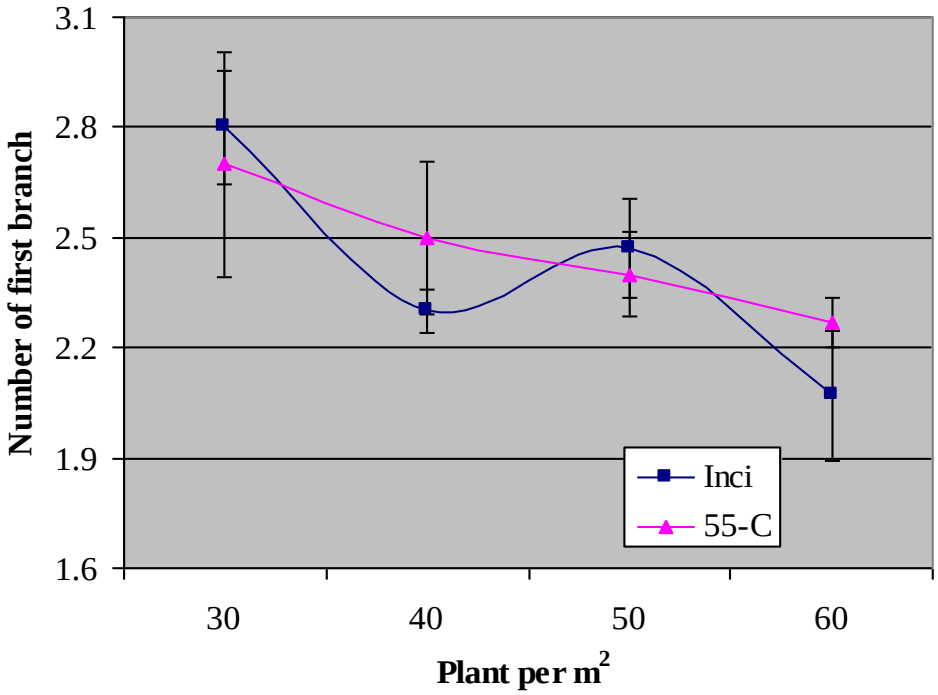

Figure 2. Relationship between genotype and plant density for first branch number in chickpea (*Cicer arietinum* L.)

Stem diameter (µm)

Plant densities showed statistically significant differences for stem diameter. The largest stem diameters were observed in 30 and 40 plants m^{-2} density of chickpea (574 and 545 µm, respectively), on the other hand, the

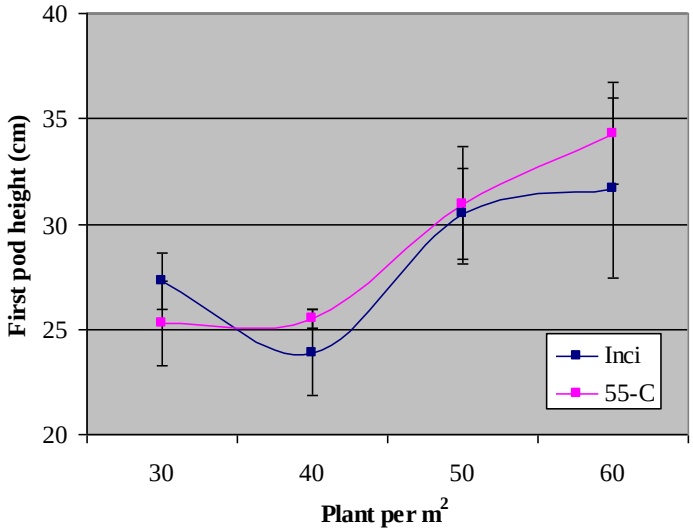

Figure 4. Relationship between genotype and plant density for first pod height in chickpea (*Cicer arietinum* L.)

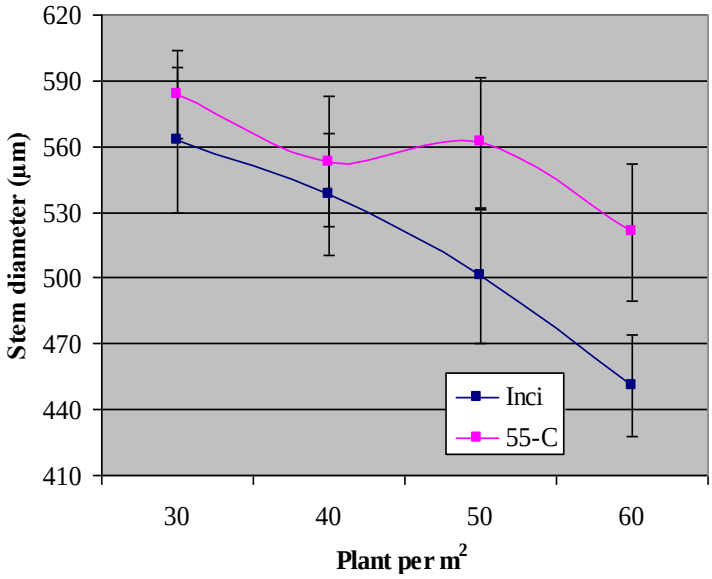

Figure 5. Relationship between genotype and plant density for stem diameter in chickpea (*Cicer arietinum* L.)

narrow was observed in 60 plants m^{-2} (486 µm). The stem diameter increases when the plant density decreased which showed that increased plant density caused a competition between chickpea plants.

Significant variation on stem diameter was found between 55-c line and Inci cultivar. 55-c have had wider stem diameter (555 µm) than Inci cultivar (513 µm). Stem diameter should be characteristic of the genotypes of the chickpea and it may vary depending on the variety.

Relationship between genotype and plant density for stem diameter is shown in Figure 5.

REFERENCES

Adhikari G, Pandey MP (1982). Genetic variability in some quantative characters on scope for improvement in chickpea. Chickpea Newsletter June Icn, 7:4-5.

Abbas SR (1990). Effect of varying seeding rates and P levels on the growth and yield performance of lentil. MSc. Thesis, University of Agriculture, Faisalabad, Pakistan, pp. 82.

Anonymous (1985). Chickpea Descriptors. International board for plant genetic resources (Ibpgr) and International center for agricultural research in the dry areas (Icarda), International crop research institute for the semi-arid tropics (Icrisat). AGPG: IBPGR/85/35, pp. 15.

Aslam M, Mahmood IA, Ahmad S, Peoples MB, Herridge DF (1997).

Survey of chickpea N_2 - fixation in the Potohar and Thal areas of Punjab Pakistan. In: Extending nitrogen fixation research to farmer's fields: International Workshop on Managing Legume Nitrogen Fixation in the Cropping Systems of Asia, 20-24th August, ICRISAT Asia Center, pp. 353-360.

Anonymous (2011a). Fao statistical database. http://faostat.fao.org.

Anonymous (2011b). Turkish state meteorological service data's. http://www.dmi.gov.tr.

Azizi K, Kahrizi D (2008). Effect of nitrogen levels, plant density and climate on yield quantity and quality in cumin (*Cuminum cyminum* L.) under the conditions of Iran. Asian J. Plant Sci., 7(8): 710-716.

Bakry BA, Elewa TA, El-Karamany MF, Zeidan MS, Tawfik MM (2011). Effect of row spacing on yield and its components of some faba bean varieties under newly reclaimed sandy soil condition. World J. Agric. Sci., 7(1): 68-72.

Berger JD, Turner NC (2007). The ecology of chickpea: evolution, distribution, stresses and adaptation from an agro-climatic perspective. In: Yadav, S.S., Redden, R., Chen, W., Sharma, B. (Eds.), Chickpea Breeding and Management. CABI, Wallingford, UK, pp. 47-71.

Chavan JK, Kadam SS, Salunkhe DK, Beuchat LR (1987). Biochemistry and technology of chickpea (*Cicer arietinum* L.) seeds. Crit. Rev. Food. Sci. Nutr., 25(2): 107-158.

Cokkizgin A (2007). A research on determination of botanical and agronomic properties of local genotypes of some lentils (*Lens culinaris* Medik.) selected from South and Southeastern Anatolian Regions in Turkey. Department of Field Crops Institute of Natural and Applied Sciences University of Cukurova, pp. 127.

Colkesen M, Cokkizgin A (2007). The Effect Of Different Row Spacing And Intra-Row Spacing On The Yield And Yield Components Of Chickpea (*Cicer arietinum* L.) Plant In Kahramanmaras Conditions. GAP (Southeastern Anatolia Project) Agriculture Congress V, 17-19 October Sanliurfa/Turkey, pp. 297-304.

Duzgunes O, Kesici T, Gurbuz F (1987). Statistical Methods I. Ankara University, Agricultural Engineering Faculty Press: 861, pp. 229.

El-Karamany MF, Bahr AA (1999). Effect of mineral fertilization, organic manuring and biofertilization on yield and yield components of chickpea (*Cicer arietinum* L.) cultivars in sandy soil. Egypt J. Appl. Sci., 14(11): 68-76.

Fatima Z, Alsam M, Bano A (2008). Chickpea nitrogen fixation increases production of subsequent wheat in rain fed system. Pak. J. Bot., 40(1): 369-376.

Felton WL, Marcellos H, Murison RD (1996). The effect of row spacing and seeding rate on chickpea yield in Northern New South Wales. Proc.8th Aust. Agron. Conf. Toowoomba, pp. 251-253.

Hedley CL (2001). Carbohydrates in grain legume seeds: Improving nutritional quality and agronomic characteristics. Wallingford, Oxon, GBR: CABI Publishing, pp. 1-14.

Hintz RW, Albrecht KA, Oplinger ES (1992). Yield and quality of soybean forage as affected by cultivar and management practices. Agron. J., 84: 795-798.

Hulse JH (1991) Nature, composition and utilization of grain legumes. In: Patencheru, A.P. (Ed), Uses of tropical legumes. Proceedings of a consultants meeting, 27-30 March 1989. ICRISAT center, ICRISAT, India, pp. 502-524.

Jasinska Z, Kotecki A (1995). The influence of row spacing and sowing rate on the growth, yield and nutritive value of horse bean. I. Development and morphological characteristics. Roczniki Nauk Rolniczych. Seria A, Produkcja Roslinna, 111(1-2): 143-153.

Joshi PK, Parthasarathy RP, Gowda CLL, Jones RB, Silim SN, Saxena KB, Kumar J (2001). The World chickpea and pigeonpea economies: facts, trends, and outlook. International Crops Research Institute for the Semi-Arid Tropics: Patancheru, Andhra Pradesh, India, p. 68.

Kahrizi D, Salmanian A.H, Zebarjadi AR (2011). Effect of cultivar and density of cultured cotyledons on shoot regeneration in rapeseed (*Brassica napus* L.). Agric. Biotechnol., 9(2): 1-6.

Khan RU, Ahad A, Rashid A, Khan A (2001). Chickpea production as influenced by row spacing under rainfed conditions of Dera Ismail Khan. J. Biol. Sci., (3): 103-104.

Krouma A (2009). Physiological and nutritional response of chickpea (*Cicer arietinum* L.) to salinity. Turkish J. Agric. For., 33: 503-512

Krzyzanowski J (2010). Review and identification of research needs to address key issues related to reactive nitrogen (RN) deposition and eutrophication in a canadian context (Final Report). Canadian Council of Ministers of the Environment, p. 95.

Ladizinsky G, Adler A (1976). Euphytica, The origin of chickpea *Cicer arietinum* L., 25(1): 211-217.

Martin I, Tenoria JL, Ayerbe L (1994). Yield, growth and water use of conventional and semi-leafless peas in semi-arid environments. Crop Sci., 34: 1576-1583.

Muzquiz M, Wood JA (2007). Edited by Yadav SS., Redden R., Chen W., Sharma, B., Chickpea breeding and management. Antinutritional Factors. 6: 143-166

Khan EA, Aslam M, Ahmad HK, Himayatullah, Khan MA, Hussain A (2010). Effect of row spacing and seeding rates on growth, yield and yield components of chickpea. Sarhad J. Agric., 26(2): 201-211.

Ozgun OS, Bicer BT, Sakar D (2004). Agronomic and morphological characters of chickpea cultivation under irrigated conditions. Int. J. Agri. Biol., 6(4): 606-610.

Parvez AQ, Gardner FP, Boote KJ (1989). Determinate and indeterminate type soybean cultivars responses to pattern, density and planting date. Crop Sci., 29: 150-157.

Rao DLN, Giller KE, Yeo AR, Flowers TJ (2002). The effects of salinity and sodicity upon nodulation and nitrogen fixation in chickpea (*Cicer arietinum* L.). Ann. Bot., 89(5): 563-570.

Regan KL, Siddique KHM, Martin LD (2003). Response of Kabuli chickpea to sowing rate in Mediterranean-type environments of South-Western Australia. Australian J. Exper. Agric., 43(1): 87-97.

Sarwar MY (1998). Effect of different fertilizer doses and row spacing on growth and yield of gram (*Cicer arietinum* L.). MSc. Thesis, University of Agriculture, Faisalabad, Pakistan, pp. 76.

SAS (2004). SAS/STAT 9.1. User's guide: Statistics. SAS institute Inc., Carry, NC, USA, p. 5121.

Shamsi K (2009). The effects of planting density on grain filling, yield and yield components of three chick pea (*Cicer arietinum* L.) varieties in Kermanshah, Iran. J. Animal Plant Sci., 2(3): 99-103

Shamsi K, Kobraee S, Rasekhi B (2011). The effects of different planting densities on seed yield and quantitative traits of rainfed chickpea (*Cicer arietinum* L.) varieties. Afr. J. Agric. Res., 6(3): 655-659.

Sharar MS, Ayub M, Nadeem MA, Noori SA (2001). Effect of different row spacings and seeding densities on the growth and yield of gram (*Cicer arietinum* L.). Department of Agronomy, University of Agriculture, Faisalabad, Pakistan. 38(3-4): 51-53.

Siddique KHM, Brinsmead RB, Knight R, Knights EJ, Paull JG, Rose IA (2000). Adaptation of chickpea (*Cicer arietinum* L.) and faba bean (*Vicia faba* L.) to Australia. In: "Linking research and marketing opportunities for pulses in the 21st century". (Ed. Knight, R.) Kluwer academic Publishers, pp. 289-303.

Singh A, Prasad R, Sharma PK (1988). Effects of plant type and population density on growth and yield of chickpea. J. Agric. Sci., 110(1): 1-4.

Singh KB, Singh D, Singh DN, (1979). Response of field pea to population density and phosphorus levels. Indian J. Plant Physiol., 23: 185-191.

Togay Y, Togay N (2001). Effect of different row spaces on some agronomic characters in chickpea (*Cicer arietinum* L.). Yuzuncu Yil University J. Agric. Sci., 7(2): 32-35

Togay N, Togay Y, Erman M, Yusuf D, Cig F (2005). The effects of different plant densities on yield and yield components in some chickpea (*Cicer arietinum* L.) cultivars in dry and irrigated conditions. J. Agric. Sci., 11(4):417-421.

Vanderpuye AW (2010). Canopy architecture and plant density effect in short-season chickpea (*Cicer arietinum* L.). The Doctorate of Philosophy (PhD) Thesis, Department of Plant Sciences University of Saskatchewan, Saskatoon, p. 178.

Williams PC, Singh U (1988). Quality screening and evaluation in pulse breeding. In: Summerfield RJ (ed.) World crops, cool season food legumes. Kluwer Academic Publishers, Dordrecht, pp. 445–457.