Research Journal of
Seed Science

ISSN 1819-3552

Academic
Journals Inc.

www.academicjournals.com

Research Journal of Seed Science 3 (3): 170-177, 2010
ISSN 1819-3552 / DOI: 10.3923/rjss.2008.11.18

Effect of Sowing Depths and Seed Size of Some Winter Cultivars of Chickpea (*Cicer arietinum* L.) on Field Emergence and Vegetative Growth*

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Abstract: The research was accomplished at Agriculture College farms (Duhok) and Agricultural Research Center at Zakho area, during the winter growing season 2005-2006, to investigate the effect of sowing depths and seed sizes on seedlings emergence percentage and vegetative growth of some winter varieties of chickpea (*Cicer aritenum* L.) under rainfall conditions of Duhok Governorate, Iraqi Kurdistan Region. The factorial Split-Split plot within the Randomized Complete Block Design experiment with three replications was designed. The comparisons between the means were tested by least Significant Difference at probability level 5%. Results indicated that sowing depths have no significant effect on any of the traits at both locations. Medium seeds were superior in seedlings emergence percentage; large seeds manifested higher plant height, height of the lowest pod and number of primary branches at both locations; chickpea varieties dose not have significant effect on seedling emergence at both locations and on height of the lowest pod and primary branches at Duhok, while Ghab4 and Gahb5 produced highest plants at both locations. Ghab4 was superior in height of the lowest pod, but Ghab3 and Ghab4 were higher in number of primary branches at Zakho site. Variety Ghab3 at 12 cm sowing depth recorded highest seedling emergence percentage and lowest plant height at Duhok, while at Zakho, Ghab3 at both depths was inferior in plant height and at 6 cm depth in height of lowest pod, but it gave significantly highest number of primary branches. Large or medium seeds at both depths resulted higher values for studied traits. The interactions between all studied factors were also significant.

Key words: Seed size, sowing depth, winter cultivars, seedling emergence, vegetative growth, chickpea germination

INTRODUCTION

Chickpeas (*Cicer arietinum* L.) rank as the third most important grain legume in the world after dry bean and peas. It is a cool-season annnal pulse crop, which is grown in tropical, subtropical and temperate regions of the world. Seeds nutritionally are free from various antinutritional factors, it has high protein digestibility and is richer in phosphorus and calcium than other pulses. It possess higher fat content and better fiber digestibility; also a source of protein and calorie for animal feed for both ruminants and non-ruminants. Chickpea straw has a forage value comparable to other straws commonly used for livestock feed (Saxena and Singh, 1987).

The demand for chickpea has increased, as it is use in many public national foods and in various commodities and recipes that are varies between different countries.

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Originally Published in Research Journal of Seed Science, 2008

Chickpea is the second most important grain legume after faba bean in Iraq. Its cultivation is concentrated in the northern governorates including Sulaymania, Duhok, Erbil and Musel covering an area of 14.000 ha with average yield of 0.74 t ha^{-1} (Abbas, 1990), which comprises 6.4% ouly of the total consumption and the remaining provided by importation. Like all Mediterranean basin, chickpea is the only pulse crop that is sown in Iraq in spring without irrigation, whereas other cool-season legumes such as faba bean (*Vicia faba* L.) and pea (*Pisum sativum* L.) are grown as a winter-sown crops. However, studies on the date of sowing of chickpea have led the workers to realize that yield can be considerably ameliorating with adequate water availability and much longer reproductive period.

In this area farmers usually sown chickpeas in spring (February-March); they have their generally speaking about chickpea growing: One rain is little and two are access. This was derived from their experience of the weather, since early sowing in very wet conditions (winter sowing) causes many diseases, especially Ascochyta blight, which has been reported to be the most destructive disease in 32 countries (Nene, 1988); troubles in weed control, lodging and sometimes a complete loss of the product The limited area cultivated by chickpea and the low productivity per unit area in Iraqi Kurdistan region, rather than suitable climatic conditions (weather and fertile soil), are due to numerous obstacles confronting chickpea growing of local varieties (spring varieties) with the traditional methods, absence of mechanization especially in the harvesting process that reduce economic return and the spreading of pests.

The advantage of winter sowing over spring sowing has been demonstrated in all the countries of the Mediterranean basin, North Africa, Asia and Southern Europe such as yield increase, greater water use efficiency, more nitrogen fixation, less disease infection and fully mechanization of the production (Rheenen and Saxena, 1990).

Chickpea is a hypogeal germinated legume and there is a shortage in studies related to the proper depth for planting to this context. Increasing of sowing depth may benefit for crop establishment as additional moisture is available in the subsoil, thus reducing the likelihood of lodging. However, it may lead to increasing the variability in the time of emergence. Slower emergence provides a longer period for the safe application of pre-emergence herbicides. It may also improve the survival of *Rhizobium* inoculated on the seed resulting in better nodulation, because soil temperature and moisture at the depth tend to be more favorable than closer to the soil surface. It also reduces the risks of birds digging up the seeds and up-rooting the seedlings or heaving. On the other hand, the use of small seeds can reduce the production costs of Kabuli chickpea by 15 to 25% by reducing the amount of seed needed per unit area (Gan *et al*., 2003).

The study was aimed to investigate the effect of sowing depths (6 and 12 cm) and seed sizes (small, medium and large) on seedlings emergence percentage and vegetative growth of some winter varieties of chickpea (Ghab3, Ghab4 and Ghab5) under rainfall conditions of Duhok Governorate, Iraqi Kurdistan Region. Many studies have been signed the mentioned factor's effect on the growth of chickpea (Ali *et al*., 1995; ICRISAT, 1986; McKay *et al*., 2002; Singh *et al*., 1997) reported that sowing of winter cultivars will leading to extend the growth period and utilize more stored moisture which influence positively on growth characters. As regard seed size (Eser *et al*., 1991; Khalaf *et al*., 2003; Roy *et al*., 1994; Varshney, 2003) found that the large seeds of chickpea recorded superiority in growth traits as compared to small seeds, while Gan *et al*. (2000) reported that the size of seeds has no significant impact on plant growth. On the other hand, Khan *et al*. (1999), Saxena and Singh (1987) and Siddique and Loss (1999) were showed that the plant growth is better in deep sown, but Abbas and Murad (2001) reported that the sowing depth has no significant effect on most of growth characters of chickpea.

MATERIALS AND METHODS

The experiment accomplished during the growing season 2005-2006 at two locations, Research Farm of Field Crops in the College of Agriculture, University of Duhok (situated between longitudes

43.01°E, latitudes 36.847°N and altitude 583 m) and the second location was the Agricultural Research Center at Zakho area (situated between longitudes 42.41°E, latitudes 37.8°N and altitude 433 m and about 70 km far from Duhok), the climate is continental and sub-tropical, which is characterized by a cool to cold winter with possible temperature below zero and a hot summer with temperature elevating up to 40°C. The region is located in a secured and semi-secured rain zone.

Three winter Kabuli varieties of chickpea (*Cicer arietinum* L.) (Ghab3, Ghab4 and Ghab5) were developed by the International Center for Agriculture Research in the Dry Area (ICARDA); their registration numbers were reported by (Singh *et al*., 1997) as: Ghab3, Ghab4 (Reg. No. CV-245, PI 638616) and Ghab5 (Reg. No. CV-246, PI 638617). Seeds with 100% purity for each variety were graded into three sizes (small, medium and large) using sieves of 7 and 8 mm aperture's diameter.

Seed viability was estimated by germinating four replicates of 50 seeds drawn randomly from each variety incubated at 20°C for 8 days (ISTA, 1985) which was 100%. Seeds were dressed before sowing with the fungicide (Dithane S-60) at the rate of 2 g kg^{-1} seeds by placing seeds for each variety in a small polyethylene bag and mixed thoroughly with the fungicide (Hansing, 1974) to protect seedlings from fungal infection during early seedling establishment. The required seeds for each experimental unit (100 seeds) were kept in a small paper bag. The experiment was applied at Duhok (532.1 mm rainfall) and Zakho location (636.3 mm rainfall) in clay soil at both locations.

The fields at both locations were plowed with a disk plow two weeks prior to planting, mass of the soil was pulverized by rotyvator and the field was leveled manually before implementation of the experiment. Plots were prepared with an area of 3×1 m; the distances between plots were kept 0.5 m; between each main plot, the distance was 1 m and between replicates, it was 2 m Each plot consists of 4 lines 25 cm apart. Seeds were sown at a rate of 33 plants per square meter apart 12 cm seed to seed on 4/1/2006 and 18//1/2006 at Duhok and Zakho locations, respectively.

The seeds were sown in two depths (6 and 12 cm) which was controlled also by a special tool to achieve the accurate depth; Three factors were involved in this study, sowing depth (6 and 12 cm) as main plots, three chickpea varieties (Ghab3, Ghab4 and Ghab5) as sub plot and three size grades of seeds (small, medium and large) which represented as sub-sub-plots. The number of treatments combinations was 18 with three replications; therefore, total experimental units were 54 at each location. Hand weeding (hoeing) implemented as required; neither irrigation, nor fertilization was applied. The data were analyzed statistically according to the split-split plot design in RCBD, using the statistical analysis system (SAS, 2001), Least Significant Differences (LSD), was used for means verification and for discussion of the results under probability level of 0.05.

After seedling emergence was terminated, about 4 weeks after sowing; the emerged plants were counted in the two middle lines for each plot (experimental unit) and then expressed as a percentage from the total number of seeds sown per the two lines.

Ten plants were taken randomly (5 days before harvesting) from the middle lines of each plot for a parameter measurement of growth at the full maturity stage and then the average of these plants was calculated for each replicate:-

Plant height (cm) was measured from the soil surface to the end of the top growing point; Height of the lowest pod (cm) from the soil surface to the first pod developed by the plant and Number of primary branches (Main branches) produced from main stem.

RESULTS AND DISCUSSION

The data in Table 1 reveals that sowing depth and varieties had no significant effect on seedling emergence at both locations. While the effect of seed size was significant, the smaller seed size gave lower germination percentages at both locations, which were 91.55% at Duhok and 94.16% at Zakho. Medium seeds significantly gave best seedling emergence at both locations (95.44 and 97.11%,

Table 1: Effect of sowing depth, varieties and seed size of chickpea and their interactions on field emergence percentage (%) at both locations for growing season 2005-2006

		Duhok location				Zakho location			
		Varieties				Varieties			
Depth varieties	Depth (cm)	Ghab3	Ghab4	Ghab5	Mean of depth	Ghab3	Ghab4	Ghab5	Mean of depth
	6	93.77ab	94.11ab	88.44b	92.11a	94.00a	95.66a	97.55a	95.74a
	12	96.22a	95.33ab	95.33ab	95.63a	96.66a	93.33a	95.77a	95.25a
Mean of					**Mean of**				**Mean of**
varieties		95.00a	94.72a	91.88a	**seed size**	95.33a	94.50a	96.66a	**seed size**
Varieties	Small	92.66bc	91.33c	90.66c	91.55b	93.66bc	92.83c	96.00abc	94.16b
X seed size	Medium	98.33a	95.33abc	92.66bc	95.44a	98.66a	96.66ab	96.00abc	97.11a
	Large	94.00abc	97.50ab	92.33bc	94.61ab	93.66bc	94.00bc	98.00a	95.22ab
		Depth × varieties			**Depth ×**	**Depth × Varieties**			**Depth ×**
		× seed size			**seed size**	**× seed size**			**seed size**
Depth 6 cm	Small	90.66abcd	89.33cd	85.33d	88.44b	91.33de	95.00abcde	97.33abc	94.55ab
	Medium	98.66a	96.66abc	90.00bcd	95.11a	97.33abc	96.66abc	97.33abc	97.11a
	Large	92.00abcd	96.33abc	90.00bcd	92.77ab	93.33bcde	95.33abcde	98.00ab	95.55ab
Depth	Small	94.66abc	93.33abcd	96.00abc	94.66a	96.00abcd	90.66e	94.66bcde	93.77b
12 cm	Medium	98.00ab	94.00abc	95.33abc	95.77a	100.00a	96.66abc	94.66bcde	97.11a
	Large	96.00ab	98.66a	94.66abc	96.44a	94.00bcde	92.66cde	98.00ab	94.88ab

The letters associated the mean values for each set of means are not significantly different at p = 0.05 according to LSD; L.S.D. values: Duhok A = 5.83 B = 5.3 C = 3.4 AB = 7.56 AC = 4.90 BC = 6.00 ABC = 8.48; Zakho A = 2.14 B = 3.95 C = 2.15 AB = 5.60 AC = 3.04 BC = 3.72 ABC = 5.26 When A: Sowing Depth, B: Varieties, C: Seed size

respectively at Duhok and Zakho. According to Gan *et al.* (2003), the cotyledon of a small seeds store less energy than those of large seeds. These results are also in harmony with those of Varshney (2003) and Roy *et al.* (1994).

Concerning with the interaction between sowing depth and the varieties under study, it revealed significant at Duhok location only and the highest germination percentage (96.22%) was obtained for the interaction between 12 cm sowing depth with Ghab3 variety. Regarding the interaction between sowing depth and seed size, the small seeds at 6 cm sowing depth (88.44%), was the lower value that significantly different from all other values at Duhok location, but the small seed at 12 cm sowing depth, gave lowest percentage at Zakho location (93.77%). This may be attributed to the lighter soil texture of the later location.

Ghab3 variety with medium seed size gave highest emergence percentages 98.33 and 98.66% at the two locations, respectively. The second order interactions (sowing depth by varieties and seed size) was significant at both locations, the highest germination percentage was 98.66% for the interactions of first sowing depth with Ghab3 and medium seed size and second sowing depth with Ghab4 and large seed at Duhok location. However, it was 100% for the second sowing depth with Ghab3 and medium seed size at Zakho location (Table 1).

Table 2 shows that sowing depth has no significant effect on plant height at both locations. This could be due to the adequate rainfall and a prolonged growth stage, as the sowing was in winter, the effect of water deficit was diminished. This finds confirmation in Saxena and Singh (1987), who stated that when the crop receives irrigation, there are no differences between various sowing depths.

It is also noticed from Table 2 that Ghab4 variety gave the highest plant height (70.71 cm), which was significantly different from the heights of Ghab3 (68.36 cm). Meanwhile Ghab5 was not significantly different from other varieties at Duhok location. The variety Ghab3 gave lowest plant height (66.86 cm) as compared to 70.23 and 69.63 cm for Ghab4 and Ghab5, respectively, at Zakho location. This could be attributed to the genetic potential of each variety and its interaction with the environmental conditions. Singh *et al.* (1997) have referred to such differences between cultivars.

Table 2: Effect of sowing depth, varieties and seed size of chickpea and their interactions on plant height (cm) at both locations for growing season 2005-2006

		Duhok location				Zakho location			
		Varieties				Varieties			
Depth Varieties	Depth (cm)	Ghab3	Ghab4	Ghab5	Mean of of depth	Ghab3	Ghab4	Ghab5	Mean of depth
	6	69.87a	70.63a	69.36a	69.95a	67.02b	70.18a	69.74a	68.98a
	12	66.84b	70.80a	70.12a	69.25a	66.70b	70.27a	69.52a	68.83a
Mean of varieties		68.36b	70.71a	69.74ab	**Mean of seed size**	66.86b	70.23a	69.63a	**Mean of seed size**
Varieties × seed size	Small	64.87f	68.43de	66.93ef	66.74c	66.06d	69.13b	68.50bc	67.90b
	Medium	69.08cd	71.33ab	70.07bcd	70.16b	66.85cd	69.60b	68.63bc	68.36b
	Large	71.13abc	72.38a	72.23a	71.91a	67.66bcd	71.96a	71.76a	70.46a
		Depth × varieties × seed size			**Depth × seed size**	**Depth × varieties × seed size**			**Depth × seed size**
Depth 6 (cm)	Small	66.73g	67.50defg	66.77fg	67.00c	66.93fg	69.03cdef	69.80abcde	68.58b
	Medium	70.47abcd	71.41abc	69.77bcdef	70.55b	66.66fg	70.06abcd	67.73defg	68.18b
	Large	72.43ab	72.97a	71.57abc	72.32a	67.46defg	71.46abc	71.60abc	70.17a
Depth 12 (cm)	Small	63.00h	69.37cdefg	67.10efg	66.48c	65.20g	69.23bcdef	67.20efg	67.21b
	Medium	67.70defg	71.23abc	70.37abcd	69.76b	67.03efg	69.13cdef	69.43 bcdef	68.53b
	Large	69.83bcde	71.80abc	72.90a	71.51ab	67.86defg	72.46a	71.93ab	70.75a

The letters(s) associated the mean values for each set of means are not significantly different at p = 0.05 according to LSD; L.S.D. values: Duhok A = 6.01 B = 1.70 C = 1.23 AB = 2.40 AC = 1.74 BC = 2.13 ABC = 3.02; Zakho A = 1.93 B = 1.24 C = 1.14 AB = 1.76 AC = 1.60 BC = 1.97 ABC = 2.78 When A: Sowing Depth, B: Varieties, C: Seed size

Table 2, shows that the height of the plant increased with increasing of seed size. Large seed size gave significantly higher plant heights which were 71.91 and 70.46 cm at Duhok and Zakho locations, respectively, this may be due to greater seedling vigor that was produced from large seeds. Eser *et al.* (1991) and Roy *et al.* (1994) have all referred to the profound effect of seed size. They have mentioned that the large seeded group produced taller plants because they had a larger period of reproductive growth than the small-seeded group. It is also in agreement with the findings of Varshney (2003) and Khalaf *et al.* (2003).

The interactions between sowing depth and the varieties reveal significant differences, the highest plant height was 70.80 cm, which was obtained from the second sowing depth with variety Ghab4 at Duhok location and 70.27 cm from the same interaction at Zakho location; according to trials conducted in Syria, it was proved that Ghab4 produced taller plants that are also more tolerant to Ascochyta blight under rainfall conditions as compared with Ghab3 (Singh *et al*., 1997). The interaction between sowing depth and seed size showed superiority of the large seeds with both sowing depths at both locations, which valued 72.32 and 70.17 cm from large seeds with the first sowing depth and 71.51 and 70.75 cm from large seeds with the second sowing depth at Duhok and Zakho locations, respectively. This may be attributed to the fact that the large seeds produced more vigorous seedlings than the small seeds; it may be also due to the availability of more moisture in the soil at deeper (12 cm) than the shallower sowing (6 cm depth), similar results were obtained by Gan *et al.* (2003).

The superiority of the varieties Ghab4 and Ghab5 with large seeds is apparent from the interaction between variety and seed size in giving tallest plants at both locations: 72.38 and 72.23 cm at Duhok and 71.96 and 71.76 cm at Zakho location.

Regarding the second order interaction (sowing depth, varieties with seed size), it is noticed from (Table 3) that there are significant differences between interactions at both locations. Highest plants were produced from the interaction of first sowing depth, Ghab4 variety, with large seeds (72.97 cm) and from second sowing depth, with Ghab5 variety and large seeds (72.90 cm), at Duhok location. From the interaction between second sowing depth, Ghab4, with large seeds, highest plant height was

Table 3: Effect of sowing depth, varieties and seed size of chickpea and their interactions on height of the lowest pod (cm) at both locations for growing season 2005-2006

		Duhok location				Zakho location			
		Varieties				Varieties			
Depth × varieties	Depth (cm)	Ghab3	Ghab4	Ghab5	Mean of depth	Ghab3	Ghab4	Ghab5	Mean of depth
	6	41.83a	43.18a	40.27a	41.76a	40.36c	44.51a	41.18bc	42.02a
	12	39.57a	41.71a	41.31a	40.86a	42.91ab	43.88a	42.91ab	43.17a
Mean of varieties		40.70a	42.45a	40.79a	**Mean of seed size**	41.63b	44.10a	42.05b	**Mean of seed size**
Varieties × seed size	Small	38.00d	40.55bcd	39.40cd	39.31b	41.65cd	42.31cd	41.95cd	41.97b
	Medium	42.41abc	41.75abc	39.75cd	41.30b	41.06d	44.65ab	40.95d	42.22b
	Large	41.70abc	45.05a	43.23ab	43.32a	42.20cd	45.33a	43.25bc	43.59a
		Depth × varieties × seed size			**Depth × seed size**	**Depth × varieties × seed size**			**Depth × seed size**
Depth 6 (cm)	Small	39.83bc	39.53bc	38.56bc	39.31c	40.83efg	42.80bcde	41.53defg	41.72b
	Medium	42.96ab	43.13ab	39.20bc	41.76abc	40.13fg	46.03a	39.63g	41.93b
	Large	42.70ab	46.90a	43.06ab	44.22a	40.13fg	44.70ab	42.40bcdef	42.41b
Depth 12 (cm)	Small	36.16c	41.56b	40.23bc	39.32c	42.46bcdef	41.83cdefg	42.36bcdef	42.22b
	Medium	41.86b	40.36bc	40.30bc	40.84bc	42.00cdefg	43.26bcde	42.26bcdefg	42.51b
	Large	40.70bc	43.20ab	43.40ab	42.43ab	44.26abc	45.96a	44.10abcd	44.77a

The letters(s) associated the mean values for each set of means are not significantly different at p = 0.05 according to LSD; The letters associated the mean values for each set of means are not significantly different at P = 0.05 according to LSD; L.S.D. values: Duhok A = 8.73 B = 2.23 C = 2.01 AB = 3.16 AC = 2.83 BC = 3.47 ABC = 4.91; Zakho A = 7.88 B = 1.42 C = 1.08 AB = 2.01 AC = 1.59 BC = 1.87 ABC = 2.64 When A: Sowing Depth, B: Varieties, C: Seed size

72.46 cm at Zakho location, while the lowest heights of plants were obtained from the interaction between the second sowing depth, Ghab3 variety and small seeds (63.00 cm), at Duhok and (65.20 cm), from the same interaction at Zakho location (Table 2).

The data in Table 3 shows that the effect of sowing depth on the height of the lowest pod was not significant at both locations; this could be attributed to adequate soil moisture. This argument coincides with Saxena and Singh (1987).

There were also no significant differences between the varieties in this trait at Duhok location; the values ranged between 40.70 and 42.45 cm. While at Zakho location, Ghab4 variety gave a significantly higher value (44.10 cm); the climatic conditions at the two locations may induce such variations. Concerning seed size, large seeds were significantly higher in the height of the lowest pods at both locations (43.32 and 43.59 cm) at Duhok and Zakho, respectively, whereas there were no significant differences between medium and small seeds. One could postulate that larger seeds gave more vigorous and better seedling. The interaction between sowing depth and varieties was not significant at Duhok location. Nevertheless, at Zakho location, Ghab4 variety with both sowing depths significantly surpassed other interactions; they were 44.51 and 43.88 cm, respectively.

As regards the interaction between sowing depth and seed size, the superiority of the first and second sowing depths with large seed were noticed, (44.22 and 42.43 cm), respectively at Duhok location. While at Zakho location, the second sowing depth with large seed was significantly higher (44.77 cm). The same table reflects a significant difference among the interaction between the varieties and seed size: The highest value was recorded for Ghab4 with large seeds (45.05 cm) at Duhok location and for the same interaction (45.33 cm) at Zakho location. While the least height of the lowest pod was recorded for Ghab3 with small seeds (38.00 cm) at Duhok and 41.06 cm for Ghab3 with medium seeds at Zakho location. The genetic nature of the varieties and the high vigor of the large seeds as compared with the small seeds can offer to justify such differences (Eser *et al*., 1991).

Regarding the second order interaction, significant differences were observed between the variables. The highest height of the lowest pod at Duhok location was for the first sowing depth,

Table 4: Effect of sowing depth, varieties and seed size of chickpea and their interactions on the number of primary branches per plant at both locations for growing season 2005-2006

		Duhok location				Zakho location			
		Varieties				Varieties			
Depth × varieties	Depth (cm)	Ghab3	Ghab4	Ghab5	depth Mean of	Ghab3	Ghab4	Ghab5	depth Mean of
	6	3.33a	3.30a	3.17a	3.27a	3.12a	2.97abc	2.82bc	2.97a
	12	3.24a	3.13a	3.25a	3.21a	3.01abc	3.05ab	2.78c	2.95a
Mean of varieties		3.28a	3.21a	3.21a	**Mean of seed size**	3.06a	3.01a	2.80b	**Mean of seed size**
Varieties × seed size	Small	3.21abc	3.10bc	3.00c	3.10b	2.96bcd	2.81de	2.58e	2.78b
	Medium	3.21abc	3.18abc	3.28abc	3.22ab	2.98bcd	3.06abc	2.95bcd	3.00a
	Large	3.43a	3.36ab	3.36ab	3.38a	3.25a	3.16ab	2.88cd	3.10a
		Depth × varieties × seed size			**Depth × seed size**	**Depth × varieties × seed size**			**Depth × seed size**
Depth 6 (cm)	Small	3.36ab	3.26abc	2.80d	3.14bc	3.03abcd	2.90bcde	2.63ef	2.85cd
	Medium	3.13abcd	3.23abc	3.23abc	3.20bc	3.00abcd	2.90bcde	2.93bcde	2.94abc
	Large	3.50a	3.40ab	3.50a	3.46a	3.33a	3.13abc	2.90bcde	3.12a
Depth 12 (cm)	Small	3.06cd	2.93cd	3.20abcd	3.06c	2.90bcde	2.73def	2.53f	2.72d
	Medium	3.30abc	3.13abcd	3.33abc	3.25abc	2.96bcde	3.23ab	2.96bcde	3.05ab
	Large	3.36ab	3.33abc	3.23abc	3.31ab	3.16abc	3.20abc	2.86cdef	3.07ab

The letter(s) associated the mean values for each set of means are not significantly different at p = 0.05 according to LSD; values: Duhok A = 0.27 B = 0.16 C = 0.16 AB = 0.23 AC = 0.23 BC = 0.29 ABC = 0.41; Zakho A = 0.61 B = 0.16 C = 0.13 AB = 0.23 AC = 0.19 BC = 0.23 ABC = 0.33 When A: Sowing Depth, B: Varieties, C: Seed size

Ghab4, with large seeds (46.90 cm) and at Zakho location with the first sowing depth, Ghab4, with medium seeds (46.03 cm), followed by the second sowing depth, Ghab4, with large seeds (45.96 cm) (Table 3).

The data in Table 4 include the effect of sowing depth, which was not significant on the number of primary branches per plant at both locations. While it released a significant difference for seed size, as the large seeds group gave a higher number of primary branches 3.38 and 3.10 at Duhok and Zakho locations, respectively. Similar results were obtained by Khalaf *et al.* (2003).

The varieties did not significantly affect this trait at Duhok location and the number of branches ranged between 3.21 and 3.28. Meanwhile, at Zakho location, Ghab3 (3.06) and Ghab4 (3.01) were not significantly different and both were significantly higher than Ghab5 (2.8). The variability of the climatic conditions between both locations can trigger such variation. It could also be due to the fact that being chickpea indeterminate; the phenological stages vary with the cultivars, photoperiod, temperature and water availability (Saxena and Singh, 1987).

Sowing depth with varieties interaction was not significant for number of primary branches at Duhok location; While at Zakho, there were significant differences for this interaction. The highest value was 3.12 for the first sowing depth with Ghab3. Significant differences were recorded for the interaction of sowing depth with seed size at both locations. The highest number of primary branches per plant was obtained from the first sowing depth with large seeds 3.46 at Duhok location; and for the same interaction 3.12 at Zakho location.

The interaction between varieties and seed size also showed significant differences. The highest value was for Ghab3 and large seed size (3.43 and 3.25) at Duhok and Zakho locations, respectively. This may be due to the higher vigor of large seeds in addition to the genetic potential of the cultivars. As regard the interaction of sowing depth, varieties and seed size, it released a significant difference; the first sowing depth with Ghab3 and Ghab5 with large seed size (3.50) gave the highest values among other interactions at Duhok location and the first sowing depth with Ghab3 variety with large seed (3.33) at Zakho location (Table 4).

REFERENCES

Abbas, A.I., 1990. Status of Chickpea in Iraq. Cited from: Rheenen van H.A. and M.C. Saxena (Eds.).

Abbas, A.I. and S.S. Murad, 2001. The effect of planting depth and genotype on the production of chickpea in the rainfed area of Iraq. Iraqi J. Agric., 6: 45-53 (Arabic).

Ali, J.J.M., S.I. Tofiq and I.M. Ahmed, 1995. Evaluation of some winter chickpea varieties under dry farming. J. Zankoy Sulaimani. 1 (1).

Eser, D., A. Ukur and M.S. Adak, 1991. Effect of seed size on yield and yield components in chickpea. Int. Chickpea Newslett., 25: 13-15.

Gan, Y., B.G. McConkey, P.R. Miller, R.P. Zentner and C.L. McDonald, 2000. Chickpea in semiarid cropping systems. Semiarid prairie agricultural research centre. http://www.weeds.montana.edu/systems/chickpea_in_semiarid.htm, Montana State University.

Gan, Y.T., P.R. Miller and C.L. McDonald, 2003. Response of kabuli chickpea to seed size and planting depth. Semiarid prairie agricultural research centre. Can. J. Plant Sci., 83: 39-46.

Hansing, E.D., 1974. Evaluation of seed treatment fungicides. Fungicide and Nematicide Tests, 30: 1-3.

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics), 1986. Chickpea Breeding Progress Report 32. Quoted from: Rheenen and Saxena (Eds.),

ISTA, 1985. International Rules for Seed Testing Association (Seed science and technology).

Khalaf, A.S., M. Ghanim and M.A. Al-Noori, 2003. Effect of seed size, sowing methods and plant populations on growth and yield of local chickpea (*Cicer arietinum* L.). Iraqi J. Agric. Sci., 5: 55-58.

Khan, S.A., N. Islam, M. Biswas, A.K.M.H. Akhter and N.A. Sardar, 1999. Effect of seeding depth and seed rate on the growth and yield of chickpea (*Cicer arietinum* L.). Bang. J. Sci. Ind. Res., 34: 248-253.

McKay, K., P. Miller, B. Jenks, J. Riesselman, K. Neill, D. Buschena and A.J. Bussan, 2002. Growing Chickpea in the Northern Great Plains. North Dok. State Uni. NDSU ext. service,A-1236.http://www.ag.ndsu.nodak.edu/.

Nene, Y.L., 1988. Multiple diseases resistance in grain legumes. Ann. Rev. Phytopathol., 26: 203-217.

Rheenen van H.A. and M.C. Saxena, 1990. Chickpea in the Nineties. Proceeding of the Second International Workshop on Chickpea Improvement 4-8 Dec., 1989. ICRISAT Center, Patancheru, A.P. (Ed.), India, pp: 502-324.

Roy, A., S.R. Paul and R.N. Sarma, 1994. Effect of seed size on germination and seed vigor in chickpea (*Cicer arietinum L.*). Ann. Agric. Res., 15: 383-384.

SAS, 2001. SAS/STAT\User's Guide for personal computers. Release 6.12. SAS Institute Inc, Cary, NC, USA.

Saxena, M.C. and K.B. Singh, 1987. The Chickpea. The International Center for Agriculture Research in the Dry Area (ICARDA), P.O. Box 5466, Aleppo, Syria. C.A.B. International, Wallingford, UK.

Siddique, K.H.M. and S.P. Loss, 1999. Studies on sowing depth for chickpea (*Cicer arietinum* L.), faba bean (*Vicia faba* L.) and lentil (*Lens culinaris* Medik) in a Mediterranean-type envirounent of South-Western. J. Agron. Crop Sci., 182: 105-112.

Singh, K.B., R.S. Malhotra, M.C. Saxena and G. Bejiga, 1997. Superiority of winter sowing over traditional spring sowing of chickpea in the Mediterranean region. Agron. J., 89: 112-118.

Varshney, S.K., 2003. Effect of seed size on the seed yield and qnality of chickpea. Int. Chickpea Pigeonpea Newslett., 10: 5-6.