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Effect of late Sowing and Hydropriming Time on some Seed Vigour Attributes of Five Chickpea (*Cicer arietinum* L.) Lines

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Abstract: A set of laboratory tests was conducted in 2015, at the Central Seed laboratory Seed Administration**,** Ministry of Agriculture and Forestry, Khartoum, Sudan, with the objective to investigate the effect of late sowing and hydro priming times on some seed vigour attributes of five chickpea lines (DR1-27-5; DR1-44; DR1-109; DR1-114 and DR1-115). Seeds were provided by Hudeiba Research Station, from planting at optimum sowing date (November); late sowing (January) of the harvest of season 2011/2012**.** The experiment was conducted in completely randomized design with four replications. Treatments were sowing dates (2), hydropriming time (4) and chickpea lines (5) Data were collected on initial moisture content, 100 seed weight, germination percentage and rate, seedling fresh and dry weights. The results indicated that late sowing had highly significant ($P \leq 0.01$) effect on seed vigour by affecting seed moisture content, 100 seed weight, germination percentage and seedling dry weight. The lines and hydropriming time showed significant ($P \leq 0.01$) effect on all studied parameters. There were positive significant ($P \leq 0.01$) correlation between moisture content, 100-seed weight, germination percent and seedling fresh and dry weights; but all these parameters were negatively correlated with rate of germination. Further studies are needed to investigate, in depth, the mechanism of heat tolerance and determination of the appropriate hydro-priming time for chickpea seeds.

Key words: chickpea; late sowing; seed vigour; hydropriming

INTRODUCTION

In Sudan chickpea (*Cicer arietinum* L.) is grown traditionally during the winter season in the northern part of the country as an irrigated crop. Recently, the crop has been successfully grown in Hawata area in Eastern Sudan and Jabel Marra in Western Sudan as well as Gezira Irrigated Scheme (Faki *et al*. 1992). The average area under chickpea in recent years reached 7500 ha (FAO 2013), its yield ranges between 0.83 and 1.8 t/ha. Chickpea is either grown during the post-rainy season on stored soil moisture or as a Mediterranean winter crop on in-season rainfall; in both instances the crop is exposed to terminal drought which is accompanied by rising temperatures.

In Sudan, Ageeb and Ayoub (1977) reported that for irrigated chickpea on alkaline clay soil heat stress encountered during late sowing date affected yield by influencing growth; major yield components per plant and plant stand.

In arid environments, crop varieties with high seedling vigour and good stand establishment tend to maximize use of available soil moisture, resulting in increased dry matter accumulation and improved grain yield. The relatively narrow genetic base of cultivated chickpea is another reason why high temperature has such a detrimental effect on growth and reproductive physiology (Abbo *et al*. 2003a) and most probably genetic variation for heat tolerance.

Hydro-priming of seeds can be used to improve the germination and seedling establishment in low humidity conditions and low temperatures. Seed priming techniques include treatments that have an influence on metabolic, biochemical and enzymatic status of seed, thereby raising its power in order to better perform their biological functions, such as germination and seedling establishment (Farooq *et al*. 2006).

One of the most important characteristics of seed quality is high seed vigour (*e.g.* germination, rate of germination ... etc). Generally seed quality and vigour are subjected to genotypic × environmental (G × E) effects that seem to be related to abiotic stress, particularly rise in temperature in Kabuli chickpea (Leport *et al*. 1999). Whilst heat stress is expected to play a role here, its effects have not been well studied.

The effects of heat stress during the vegetative and reproductive growth stages using agronomic, phenological, morphological and physiological assessment has been studied in various crops such as rice

(Weerakoon *et al*. 2008) and cotton (Cottee *et al*. 2010), whilst only limited research has been conducted on chickpea (Wang *et al*. 2006).
The objective of this study was to investigate the effect of late sowing and hydro- priming time on some seed vigour attributes of chickpea.

MATERIALS AND METHODS

Seed samples of five chickpea lines were provided by Hudeiba Research Station, (Table 1). These lines were recombinant inbred lines. Seed samples were from planting at optimum sowing date in November; late sowing date in January and harvest of season 2011-2012.

Table 1. Chickpea lines harvested at 2011- 2012 (Hudeiba - Sudan)

Lines	Abbreviation
DR1 – 27 – 5	V1
DR1 – 44	V2
DR1 – 109	V3
DR1 – 114	V4
DR1 – 115	V5

A set of laboratory tests was carried out on seed of chickpea lines to study the effects of sowing date on seed and quality attributes. The laboratory tests were conducted at the Central Seed Laboratory, Seed Administration-Ministry of Agriculture and Forestry, Khartoum, Sudan in 2015.
To study the vigour of the seed samples, different laboratory vigour tests were conducted, which included: seed moisture content, 100 seed weight, standard germination, rate of germination, seedling fresh weight and seedling dry weight. Seeds were subjected to hydration – dehydration (hydro-priming) for 0; 2; 4; and 8 hours; the same above mentioned tests were conducted and data were collected.
The experiment was factorial in a completely randomized design (CRD) with four replicates and eleven treatments (five lines, four hydropriming times and two sowing dates)

Seed moisture content

Seed moisture content was determined by weighing 25 seeds in a clean preheated dishes of known weight replicated four times using a sensitive balance. The seed samples were heated in an oven set at 130 ± 1˚C for an hour. The samples were covered and transferred to desiccators and weighed after reaching room temperature.
The loss of weight was calculated as a percent of sample weight and expressed as moisture content as follows:

$$\text{Moisture content } \% = \frac{Wt_1 - Wt_2 \times 100}{\text{sample weight}}$$

Where:
Wt_1= Weight of sample + weight of dish before oven dry
Wt_2 = Weight of sample + weight of dish after oven dry

Hundred Seed Weight (g)

Seed weight was determined by weighing hundred seeds, counted randomly by hand, and replicated four times and the average seed weight was calculated.

Standard Germination Test

For each line 100 seeds in four replications of 25 seeds each, were germinated in double moist towel paper (20 × 100 cm) and the seeds were placed two cm apart to avoid contact of seedlings during germination. After planting, a third moist towel paper was placed over the seeds and the towels were loosely rolled. To preserve moisture, rolls were placed in polythene bags and set upright in plastic boxes. Seeds were germinated in a germination room at 25± 1Cº for eight days.
At the end of the incubation period the towels were removed and the number of normal seedlings was recorded and the germination percentage was calculated as follows:

$$\text{Germination } \% = \frac{\text{Number of normal seedling}}{\text{Number of seeds planted}} \times 100$$

Rate of Germination

The test was carried out as per standard germination test described above. Daily count of normal seedlings was recorded and vigour index was calculated by multiplying the number of seeds germinated in a specific day by the reciprocal of the day on which the germinated seedlings were recorded.

$$x = \frac{\text{Number of } normal\ seedlings}{\text{Days of first count}} + \cdots \ldots\ldots + \frac{\text{Number of } normal\ seedlings}{\text{Days of final count}}$$

Seedling Fresh Weight

The seedling fresh weight (g) was assessed after the final count in the standard germination test (eight days). The fresh seedlings were weighed to the nearest milligram and the average seedling fresh weight was calculated.

Seedling Dry Weight

The seedling dry weight was determined after the final count in standard germination test. The seedlings were and dried in an oven set at 65 ± 1˚C for 24 hours. The dried seedlings were weighed to the nearest milligram and the average seedling dry weight was calculated.

Hydration – Dehydration (Hydro-priming)

Seeds before planting were exposed to 4 hydro-priming times (2h, 4h, 8h and control). For hydro-priming treatments, the required sizes of seed samples were placed in plastic containers, and then distilled water was added to the seeds for 2, 4 and 8 hours. The seeds were then air dried to reach the initial weight (humidity). The vigour tests studied included: standard germination, rate of germination, seedling fresh weight and seedling dry weight.

Statistical Analysis

The collected data were subjected to the analysis of variance (ANOVA). Mean separation was done according to Duncan's Multiple Range Test (DMRT) for different characters (Gomez and Gomez, 1984). Simple correlation coefficients were calculated to analyse the association between the tested characters.

RESULTS

Initial seed moisture content

The analysis of variance for seed moisture content revealed highly significant differences ($P \leq 0.01$) among lines and sowing dates but their interaction was not significant. Line (V4) had the highest mean moisture content followed by V5 and V1 which were not significantly different from each other but significantly different from V3 and V2. At late sowing date V4 recorded higher moisture content and the overall mean at optimum (O) sowing date was significantly higher than that at late (L) sowing date (Table 2).

Table 2. Effect of chickpea lines, sowing date on initial moisture content (%) and 100 seed weight (g)

Lines (V)	Moisture content			100 seed weight		
	Sowing Date (SD)					
	Optimum (O)	Late (L)	Means	Optimum (O)	Late (L)	Means
V1	3.3 a	3.1 a	3.2 a	26.4 bc	25.9 c	26.2 a
V2	2.3 a	2.7 a	2.8 b	24.9 cd	23.6 d	24.3 b
V3	2.9 a	2.8 a	2.8 b	22.6 de	20.4 e	215 c
V4	3.5 a	3.2 a	3.3 a	29.9 a	24.2 d	27.1 a
V5	3.3 a	3.2 a	3.3 a	28.0 b	4.0 d	26.0 a
Means	3.2 a	3.0 b		26.4 a	23.6 b	
VxSD		NS			**	

Means followed by the same letter(s) are not significantly different at $P \leq 0.5$, according to Duncan's Multiple Range Test (DMRT).
NS: not significant, **Significant at $P \leq 0.01$.

100- Seed weight

Hundred seed weight showed that there were highly significant differences ($P \leq 0.01$) due to lines, sowing dates and their interaction. The highest mean 100– seed weight was obtained by (V4) and interaction V4xO (27.01 and 29.9), respectively, (Table 2). Lines V5 and V1 had the 2nd and 3rd highest mean 100- seed weight, respectively, and were not statistically different from each other. At late sowing date V1 had the highest 100- seed weight (25.94 g) which was significantly different ($P \leq 0.01$) from all other lines. This was followed by line V4 and V5 which were not statistically different from each other or from V2.

Germination percentage

The analysis of variance of the standard germination test showed significant differences (P ≤ 0.01) among sowing dates (SD), lines (V), hydro-priming time (HT) and the interactions SDxV, SDxHT, VxHT and SDxVxHT (Table 3). Late sowing date mean was higher than that of optimum sowing date by approximately 10 % and they were significantly (P ≤ 0.01) different from each other. At optimum sowing date, V1 had significantly (P ≤ 0.01) the highest germination percentage, whereas at late sowing date V4 had the highest germination percentage which was not significantly different from V5 but significantly different (P ≤ 0.01) from V1, V2 and V3 all of which differed significantly from each other (Table 3).

Table 3. Effect of chickpea lines, sowing date and hydropriming time (h) on germination percentage

	Sowing Date (SD)		Hydropriming time (HT)				
Lines (V)	O	L	0	2	4	8	Means
V1	75.0 b	68.0 c	97.0 a	76.5 c	63.5 d	49.0 e	71.5 a
V2	48.0 f	59.5 d	89.0b	58.0 d	43.5 f	26.0 h	54.1 c
V3	43.5 g	49.5 f	90.0 b	46.5 ed	33.0 g	16.5 i	46. 5 d
V4	57.4 e	78.8 a	92.0 ab	13.0 c	60.5 d	46.5 ef	68.0 b
V5	57.0 e	77.8 a	96.0 a	71.5 c	59.0d	43.0 f	67.4 b
Means	56.3 b	66.7 a	92.80 a	65.1 b	51.9 c	36.2 d	
SDxV			**				
SDxHT			**				
VxHT			**				
SDxVxHT			**				

Means followed by the same letter(s) are not significantly different at P ≤ 0.05, according to DMRT, **Significant at P ≤ 0.01.

The mean germination percentages for the interaction SDxHT at both sowing dates were recorded at the hydro -priming times 8h, 4h, 2h and 0h, respectively. The interaction of V x HT followed a similar pattern to that described for SDxHT but the lines mean showed that V1 had significantly higher mean germination percentage at all hydro-priming times , followed by V4 which was not significantly different from V5 but differed from V2 and V3 (Table 3).

Rate of germination

Analysis of variance revealed that the rate of germination was significantly (P ≤ 0.01) affected by lines, hydropriming times, the interactions SDxV, VxHT whereas SDxHT and SDxVxHT showed no significant effect (Table 4). The highest means for rate of germination were registered for (V3= 3.3) and (HT4= 3.4).

Table 4. Effect of chickpea lines, sowing date and hydropriming time (h) on rate of germination

Lines (V) (SD)	Sowing Date		Hydropriming time (HT)				
	O	L	0	2	4	8	Means
V1	3.1 ef	3.2 cd	2.8 h	3.3 cde	3.4 abcd	3.1 fg	3.2 c
V2	3.2 de	3.2 e	3.0 gh	3.2 def	3.0 abcde	3.1 ejg	3.2 c
V3	3.4 a	3.3 bc	2.9 h	3.4 abcd	3.5 a	3.5 ab	3.3 a
V4	3.2 de	3.3 b	2.8 h	3.2 cdef	3.4 abc	3.3 ab	3.2 b
V5	3.3 b	3.1 f	2.9 h	3.3 bcdef	3.3 bcde	3.3 cdef	3.2 c
Means	3.2 a	3.2 a	2.9 b	3.3 a	3.4 a	3.3 a	
SDxV			**				
SDxHT			NS				
VxHT			*				
SDxVxHT			NS				

Means followed by the same letter(s) are not significantly different at P ≤ 0.05, according to DMRT; NS: not significant; *Significant at P≤ 0.05; **Significant at P≤ 0.01.

The interaction V3xO expressed the highest rate of germination and was significantly different from other lines at optimum sowing date. The interaction V3xHT4 also had the highest rate of germination, which was significantly different from the control but was not significantly different from interactions V3xHT2, V3xHT8, V1xHT4 or V4xHT4 (Table 4).

Seedling fresh weight

The effect of lines, sowing dates and hydro-priming times on seedling fresh weight followed a similar pattern to that described for rate of germination. Statistical analysis showed that seedling fresh weight was significantly ($P \leq 0.01$) affected by lines; hydro-priming times and the interactions SDxV, VxHT and SDxHT but the sowing date and the interaction SDxVxHT had no significant effect (Table 5). The highest mean seedling fresh weights were recorded for V4 and HT0, which were significantly ($P \leq 0.01$) higher than all other means. At late sowing date V4 had the highest seedling fresh weight which was significantly different from all other lines (Table 5). The interaction of lines x hydro-priming times followed a similar pattern to that described for sowing date x hydro-priming times in germination percentage.

Seedling dry weight

Data presented in table 6 indicate that seedling dry weight was significantly ($P \leq 0.01$) affected by lines, sowing dates, hydropriming times and the interactions SDxV. The interaction VxHT and SDxHT had a significant effect at ($P \leq 0.05$) but no significant effect was recorded for SDxVxHT. The highest seedling dry weight at optimum sowing date was recorded for V4 followed by V1 which was not significantly different from V5 and both were higher than V2 and V3 (Table 6). At late sowing date V1 had the highest seedling dry weight which did not differ significantly from V4 and V5 but all three lines were significantly different from V2 and V3. Highest mean seedling dry weight across optimum sowing date was significantly higher than at late sowing date (Table 6). At both sowing dates the highest mean seedling dry weight (213.50 mg) was recorded at HT2, which differed significantly ($P \leq 0.01$) from HT4, HT8 and HT0. Across hydropriming time, the highest seedling dry weight was obtained by V1 at HT2 followed by V4 and V5 and all three were not significantly different from each other, but were significantly ($P \leq 0.01$) higher than V2 and V3. The least mean of seedling dry weight was recorded for V3 which was significantly different from V2 and both were lower than V1, V4 and V5. (Table 6).

Table 5. Effect of chickpea lines, sowing date and hydropriming time (h) on seedling fresh weight (mg)

Lines (V) (SD)	Sowing Date		Hydropriming time (HT)				
	O	L	0	2	4	8	Means
V1	889 d	899 d	1175 b	828 d	823 d	751 e	894 c
V2	748 f	831 e	1140 b	683 f	683 f	644 fg	789 d
V3	736 fg	721 g	1069 b	638 g	621 gh	588 h	728 e
V4	960 b	979 a	1276 a	884 gh	885 c	833 d	969 a
V5	980 a	926 c	1251 a	875 c	860 d	825 d	952 b
Mean	863 a	871 a	1182 a	783 b	728 c	728 c	
SDxV			**				
SDxHT			**				
VxHT			**				
SDxVxHT			NS				

Means followed by the same letter(s) are not significantly different $P \leq 0.05$ according to DMRT; NS: not significant; * Significant at $P \leq 0.05$ and **Significant at $P \leq 0.01$.

Correlation analysis

The results showed that germination percentage had highly significant positive correlation with 100-seed weight, moisture content, seedling fresh weight and seedling dry weight, while it was negatively correlated with rate of germination. The rate of germination had negative correlations with all the tests, whereas 100-seed weight was positively correlated with moisture content, seedling fresh weight and dry weight. Also the moisture content was well correlated with seedling fresh weight and seedling dry weight (Table 7).

Table 6. Effect of chick pea lines, sowing date and hydropriming time(h) on seedling dry weight (mg)

Lines (V) (SD)	Sowing Date		Hydropriming time (HT)				
	O	L	0	2	4	8	Means
V1	241 a	216 b	226 ab	239 a	228 ab	221 ab	228 a
V2	186 c	184 c	199 c	195 c	173 d	174 d	185 b
V3	166 d	152 e	160 de	164 de	159 de	154 e	159 c
V4	248 a	208 b	220 ab	236 a	231 a	224 ab	227 a
V5	241 a	208 b	210 bc	234 a	230 a	224 ab	224 a
Mean	216 a	194 b	203 bc	204 a	204 bc	199 c	
SDxV			**				
SDxHT			*				
VxHT			*				
SDxVxHT			NS				

Means followed by the same letter(s) are not significantly different $P \leq 0.05$ according to DMRT; NS: not significant, * Significant at $P \leq 0.05$. and ** Significant at $P \leq 0.01$.

Table 7. Correlation coefficients among the various vigour tests

	Rate of germination	Dry weight	Fresh weight	Moisture content	100-seed weight	Germination percentage
Rate of germination	-					
Seedling dry weight	-0.641	-				
Seedling fresh weight	-0.482	0.953**	-			
Moisture content	-0.275	0.914**	0.944**	-		
100-seed weight	-0.697	0.972**	0.943**	0.852**	-	
Germination Percentage	-0.642	0.992**	0.915**	0.902**	0.944**	-

DISCUSSION

Seed vigour is defined as the sum of those properties that determine the activity and performance of seed or seed lot of acceptable germination in a wide range of environments (ISTA 2015). Seed moisture content in this study showed highly significant differences among lines and sowing dates, also the same effects were obtained in 100seed weight. Optimal sowing date means resulted the highest values in moisture content and seed weight. The low mean values recorded for the late sowing date might be attributed to the effect of heat stress on seed development in legumes; because endosperm filling in the seed is negatively affected by high temperature, resulting in small or wrinkled seeds. Also in soybean, Egli *et al.* (2005) found that high temperature during reproductive stage produced small seeds. The probable reason for small endosperm or smaller seed size after post anthesis heat stress is that remobilization of photosynthates to the grain is reduced. A large proportion of carbohydrate is generally utilized to the grain in legumes (Davies *et al*. 1999), thus influencing seed weight. Seed development in legumes is a function of the rate and duration of embryo growth, which is in turn influenced by abiotic stresses that may lead to embryo abortion or small endosperms and under heat stress seeds are not fully developed to agronomic maturity in sensitive genotypes (Davies *et al*. 1999).

At late sowing date V4 recorded higher moisture content compared to the other lines but there were no significant differences between the lines at late or optimum sowing dates. For seed from late sowing date, V1 had the highest 100-seed weight which was significantly different from all other lines at the same sowing date. The results of this study showed a positive correlation between seed vigour and 100- seed weight for chickpea. Such results indicated that seed weight could be a good indicator for seed vigour. Positive correlation between thousand seed weight and seed vigour were reported by several authors in different crops *e.g.,* maize (Wilson *et al*. 1992).
There were highly significant differences ($P \leq 0.01$) in germination percentage between seeds from optimum and late sowing date where the latter recorded higher means. However, no such effects were found for rate of germination and seedling fresh weight, in spite of the fact that, seeds from late sowing date were exposed to high temperature during the growing season, mainly during the reproductive stage. In general, most of the small seeded cultivars possessed higher fresh weight compared with the large seeded cultivars and this could be explained by faster imbibitions and germination. Speed of germination has been suggested as a vigour test because vigorous seeds have been shown to germinate rapidly. The findings of this study showed a negative correlation between rate of germination and other vigour tests, which correlated positively with each other. These results are in agreement with those of Hampton and Coolbear, (1990) who reported negative correlations between speed of germination and other vigour tests.
Lines and hydropriming treatments affected both germination percentage and rate of germination as well as seedling fresh weight. Generally seeds from late sowing recorded higher means for germination percentage; rate of germination and seedling fresh weight compared to seed from optimum sowing date. The lines used in this study were recombinant inbred lines and some of them might be heat stress tolerant. Similar results were reported in cabbage, where Hampton and Coolbear, (1990) found no differences in speed of germination between cultivars and relationship between speed of germination and seed weight was weak.
Hydro-priming time treatments had a negative effect on germination percentage, rate of germination and seedling fresh weight. The results showed that the least values of the three tests were obtained at hydro-priming times 8h, 4h and 2h. The highest means were recorded by the

control (0h), which was not subjected to hydro-priming for seeds from both sowing dates. These results disagree with the findings of Artola *et al*. (2003), who stated that as a result of hydro-priming treatments, the metabolic activity of germination is stimulated and it gains balance in a direction that causes improvement of the germination rate, uniformity of plant growth and improvement in vigour and seedling growth. Also Afzal *et al*. (2002), reported that acceleration of germination in primed maize seeds could be due to the increasing activity of the degrading enzymes, such as α- amylase, synthesis of RNA and DNA, the amount of ATP and the number of mitochondria; and Bailly *et al.* (2000), reported that application of priming and osmo-priming in sunflower reduced germination time. The negative results of this study in chickpea might be attributed to the fact that, the seed samples used in this study were from new harvest and were stored at optimum conditions, so that the seeds had not deteriorated, whereas the beneficial effects of hydropriming are more pronounced in deteriorated seeds. Also in this case, determining the appropriate hydro-priming time is important. Penalosa and Eiraw (1993) reported that the action of unsuitable hydro-priming time had negative effects on tomato seeds.

The results of seedling dry weight showed that there were significant effects on seeds from optimum and late sowing date, line and hydropriming times which followed a similar pattern to the hydropriming time treatments as explained above. However, contrary to previous results, the highest mean value for seedling dry weight was found at 2h hydropriming treatment both for means of seeds from normal and late sowing date as well as among lines. The results of this study showed a positive correlation for dry seedling weight with vigour, this is in agreement with the findings of Steiner *et al.* (1989) who reported that seedling dry weight is one of the best single vigour tests to predict seedling emergence of wheat. Thus seedling dry weight might prove to be a good indicator of seed vigour in chickpea.

According to the results obtained it can be concluded that seed moisture content, 100- seed weight, germination percentage and seedling dry weight could be good indicators of seed vigour in chickpea. Further studies are needed to investigate in- depth the mechanism of heat tolerance in chickpea and also determination of the appropriate hydropriming time.

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تأثير الزراعة المتأخرة و مدة الغمر بالماء على بعض عوامل حيوية بذور خمس سلالات من الحمص (*Cicer arietinum* L.)

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المستخلص: أجريت مجموعة من التجارب المعملية فى العام 2015 ، بالمعمل المركزى للتقاوى، إدارة التقاوى، وزارة الزراعة والغابات، الخرطوم- السودان، لدراسة تأثير الزراعة المتأخرة و مدة الغمر بالماء على بعض عوامل حيوية بذور خمس سلالات من الحمص . أُستجلبت البذور من محطة أبحاث الحديبة إنتاج موسم 2012/2011 وكانت DR1-.27-5; DR1-44; DR1-109; DR1-114 and DR1-115 أنتجت البذور فى المواعيد المثلى (نوفمبر) والمتأخرة (يناير). نفذت التجربة بتصميم كامل العشوائية بأربعة مكررات. كانت المعاملات هي السلالات وغمر البذور لمدة 0، 2، 4، 8 ساعات وتواريخ الزراعة. جمعت بيانات عن محتوى الرطوبة للبذرة، وزن مائة بذرة، نسبة الإنبات، معدل الإنبات والوزن الرطب والجاف للبادرة. أوضحت النتائج أن لتأخير الزراعة اثرا معنويا على حيوية بذور سلالات الحمص من حيث تأثيرها على محتوى الرطوبة للبذرة، وزن مائة بذرة، نسبة الإنبات والوزن الجاف للبادرة. أظهرت السلالات الخمس ومدة غمر البذور فى الماء فروقات معنوية فى قياسات البذرة أعلاه. أظهرت النتائج وجود إرتباط معنوى موجب بين كل من محتوى الرطوبة للبذرة، وزن مائة بذرة، نسبة الإنبات والوزن الرطب و الجاف للبادرة و كل هذه الصفات لها إرتباط سلبى مع معدل الإنبات. يجب إجراء مزيد من الدراسات لبحث الية التحمل الحرارى فى الحمص و أيضا دراسة تحديد الزمن المناسب لعملية غمر البذور فى الماء.